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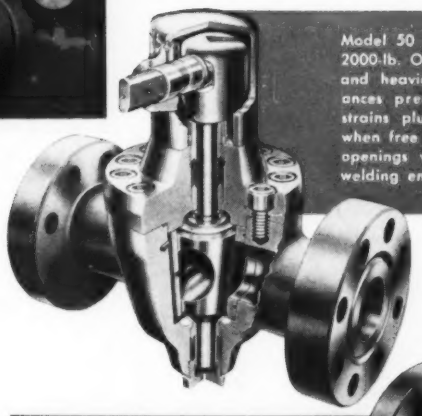
Again, ~~Cameron has~~ set a new high standard for the industry

NON-LUBRICATED

LIFT-PLUG VALVES

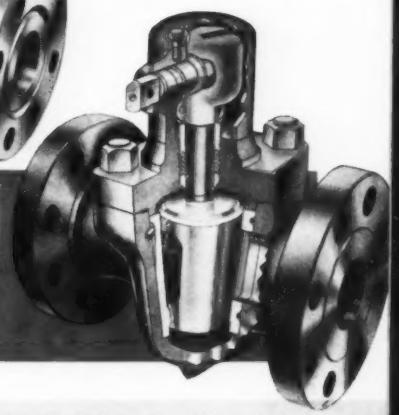
FOR DRILLING • PRODUCTION • PIPELINE • REFINING • AND GENERAL SERVICE •



Model 50 — Offered in ratings from 2000-lb. Oilfield and 600-lb Class ASA and heavier. Double stem design balances pressure thrust loads and restrains plug from lateral movement when free of seat. Full bore or regular openings with threaded, flanged or welding end bodies.

• NON-LUBRICATED • PRESSURE SEALING • LIFT-PLUG DESIGN • RENEWABLE SEAT AND PLUG • MAY BE REPAIRED IN THE FIELD • EASY OPERATION • FORGED STEEL THROUGHOUT

Literature will gladly be sent on request.



Model 51 — Offered in 300-lb. Class ASA rating only. In view of the relatively low service pressure, the additional stem below the plug is not required as in the Model 50 above. Regular opening with threaded, flanged or welding end bodies.

Cameron

IRON WORKS, INC.

P. O. BOX 1212 HOUSTON, TEXAS

EXPORT: 74 TRINITY PLACE, NEW YORK

XUM

CAN YOU DO THIS *with your present* ORIFICE METERS?

Illustrating how gauge is converted from one range to another by simply interchanging the high pressure chambers.

INTERCHANGE HIGH SIDE CHAMBERS

It's an exclusive advantage in ROCKWELL-EMCO *Orifice Meters*

The Rockwell-Emco gauge can be converted to any of six standard ranges—20", 50", 100", 200", 300" or 400", by simply unbolting one high pressure chamber and exchanging it for another. This feature permits the meter to be quickly and economically adapted to varying field conditions. It's a simple job that can be done on location.

Learn all about this conversion feature and the many other advantages of the Rockwell-Emco orifice meter. Ask the nearest District Office for a demonstration or write for bulletin 1050.

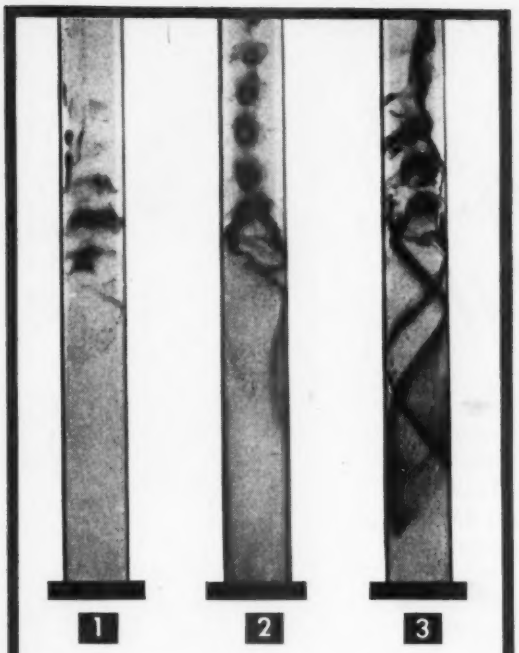
ROCKWELL MANUFACTURING COMPANY
Pittsburgh 8, Pa.
Atlanta Boston Chicago Columbus Houston
Kansas City Los Angeles New York
Pittsburgh San Francisco Seattle Tulsa

Make your Orifice Gauges the equivalent of Straight-Readers

THE ROCKWELL-EMCO INTEGRATOR

With a Rockwell Emco Integrator you can read from the dial counter the true values of recorded flow on various makes of simple flow meters. The integrator mechanically computes orifice meter charts—up to 300 average charts a day. Accuracy is assured since the operator traces the same recording of static and differential as was made by the gauge. Write for bulletin 1016.

XUM



Glass manifolds from single cylinder engines demonstrate the lessened deposit-forming tendency of Oil Blue A. Observe the small amount of deposit found in No. 1 (using Oil Blue A), compared to No. 3 in which the old Oil Blue was used. Yet the original color strength of the two gasolines tested was the same. The relatively small deposit found in No. 1 is the result, not only of the reduced deposit-forming tendency of Oil Blue A, but also of its considerably higher tinctorial strength.

No. 1 operated on gasoline containing .5 gram Oil Blue A/100 gal. gasoline.

No. 2 operated on gasoine containing 1.0 gram Oil Blue A/100 gal. gasoline.

No. 3 operated on gasoline containing .75 gram Oil Blue/100 gal. gasoline.

Du Pont Oil Blue A

Gives Desired Color Intensity with Lower Concentrations

If you use a blue dye in your gasoline, and particularly if you are producing civilian aviation gasoline, you should investigate the economy and lessened deposit forming advantages of Du Pont Oil Blue A. Meeting the requirements of Specification MIL-F-5572, it may also be used in aviation gasolines intended for military use. It is approximately 35% stronger than the previous Du Pont Oil Blue, several times as soluble, and can be used in lower concentration to obtain the desired color intensity.

Easier to use, Du Pont Oil Blue A comes in a non-caking, free-flowing, highly soluble crystalline form, thus simplifying the preparation of stock solutions or the direct dyeing of gasoline.

Ask your Du Pont Petroleum Chemicals representative for samples and complete information, or write the nearest Petroleum Chemicals District Office.

Ask your Du Pont Petroleum Chemicals representative for a copy of this bulletin on Du Pont Oil Blue A. It contains complete specifications, suggested blending schedules, and test results.

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Better Things for Better Living
. . . *through Chemistry*

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Make Du Pont the Source for All of Your Gasoline Additives . . . Tetraethyl Lead Compounds (Motor Mix—Aviation Mix)—Antioxidants—Metal Deactivator—Dyes

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No Man in the Picture

. . . and that's the way you usually see Fairbanks-Morse "ZC" Engines . . . and a big reason why they're the favorites in the fields. They rarely require attention or maintenance. Just start them and forget them. They keep right on going. There are no complicated parts . . . no delicate adjustments to cause trouble, and that's an important point with present-day high maintenance labor costs. See your supply store about a "ZC" Engine and forget your pumping problems. Fairbanks, Morse & Co., Chicago 5, Illinois.

FAIRBANKS-MORSE,

a name worth remembering

OIL FIELD EQUIPMENT • DIESEL LOCOMOTIVES AND ENGINES • ELECTRICAL MACHINERY • PUMPS • SCALES • HOME WATER SERVICE AND HEATING EQUIPMENT RAIL CARS • FARM MACHINERY

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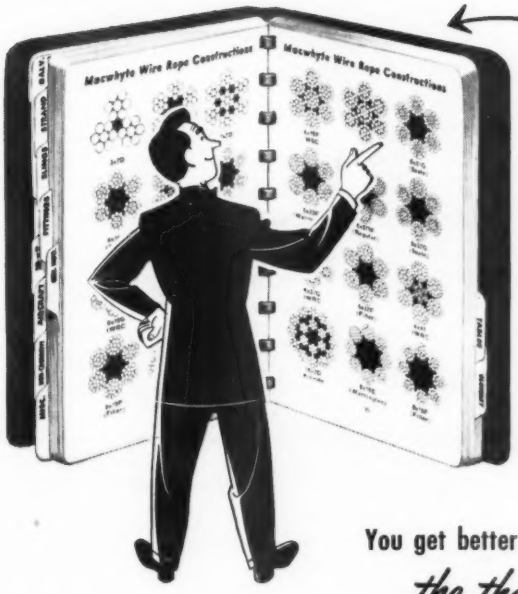
WHY guess about wire rope selection?



GET the right wire rope for each job!

You get better service when you order the right rope from

the thousand and one wire ropes made by **MACWHYTE**

A Macwhyte representative will gladly supply you with specifications for the correct rope to use on each machine you have. Call your Macwhyte distributor, or write direct to Macwhyte Company for recommendations. Catalog on request.

MACWHYTE COMPANY 2916 Fourteenth Avenue, Kenosha, Wisconsin. Manufacturers of Monarch Whyte Strand PREformed, Internally Lubricated Wire Rope, ATLAS Braided Wire Rope Slings, Aircraft Cables and Assemblies, Monel Metal and Stainless Steel Wire Rope. Mill Depots: New York • Pittsburgh • Chicago • Minneapolis • Fort Worth • Portland • Seattle • San Francisco • Los Angeles

004

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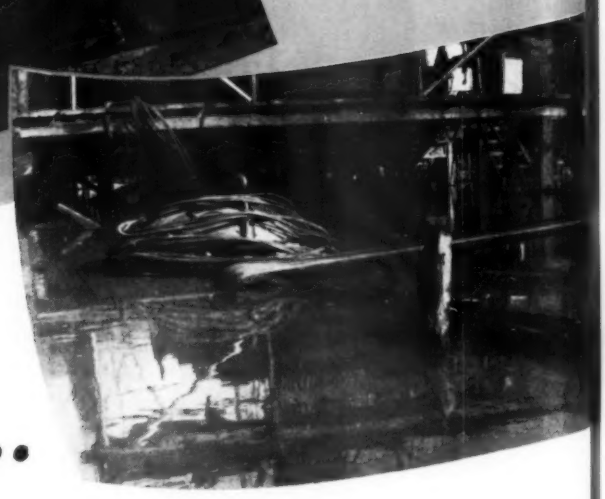
Power-end view of this "Oilwell" No. 20-P Slush Pump ready to return to service after months under water.

View of this "Oilwell" No. 20-P Slush Pump submerged in flood waters. Note the sheave, which drives the pump, barely visible above the water on extreme right hand side.



"Oilwell" Slush Pumps are *Built to last...*

BACK IN 1937, this No. 20-P Duplex Power Slush Pump went into operation. Since then it has been used in the drilling of 36 wells—a total of 324,000-feet of hole—in Louisiana, Mississippi and Texas. Included in this footage were many wells of 10,000-foot depth, one over 11,000-feet.*

In 1938 this pump was inspected, following a period of emergency operation when it was overloaded; but the only replacements necessary were crosshead pins and bearings. The pump continued to give excellent service with no major replacement of parts, other than such expendable fluid-end maintenance parts as, pistons, rods, liners and valves.

Under water for 6 months . . . back into service with only minor repairs necessary

• Operating in Alabama this "Oilwell" No. 20-P Pump was flooded on November 24, 1948. The flood waters receded early in May, 1949 but the location was reflooded before the pump could be moved. Finally on June 1, 1949 it was removed to a shop for inspection.

The only work required to put the pump back into first class condition was, (1) the replacement of the right-hand crosshead pin and bearing, which showed signs of wear after their 10-year service, (2) inside of pump was cleaned then flushed with light oil, and (3) the lubricator was dismantled and cleaned.

"OILWELL" No. 220-P PUMPS

. . . are the present heavy-duty successors to this earlier No. 20-P model embodying all the time-proved design features which make long, dependable, service records such as this possible . . . with even greater "factors of safety," larger H.P. input ratings and increased volume/pressure capacities.

COMPARE Specifications and Prices Before you BUY!

There's an "Oilwell" pump of the right size and capacity for every drilling requirement in this extensive line.

Pump No.	Max. Size by Stroke	Rated R. P. M.	B. H. P. Rating
No. 220-P	8" x 20"	60	600
No. 218-P	7¼" x 18"	60	450
No. 14P-HD	7¼" x 14"	65	325
No. 712-P	7¼" x 12"	70	220
No. 612-P	6" x 12"	70	140
No. 12-P	5" x 12"	70	100
No. 8P-HD	5" x 8"	80	85
No. 6P-HD	4" x 6"	100	40

**"Oilwell" Representatives will identify owner of this No. 20-P Pump on request . . . and GIVE YOU FACTS to help you decide on the best pump for your job.*

OIL WELL SUPPLY COMPANY

Branches Serving All Oil Fields

Executive Office—DALLAS, TEXAS
Export Division Office—
30 ROCKEFELLER PLAZA
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HOUSTON, TEXAS...TULSA, OKLAHOMA
LOS ANGELES, CALIFORNIA

USS "OILWELL" TRADE MARK

UNITED STATES STEEL

Add these advantages into your product with LINK-BELT BALL AND ROLLER BEARINGS

▶ **dependability**
in the bearings adds dependability to your product.

▶ **interchangeability**
promotes ease of assembly and service.

▶ **alignability**
compensates for deflections, assures free-rolling.

▶ **quality**
the LINK-BELT name, an assurance of quality, adds prestige to your product.

▶ **high capacities**
to carry thrust as well as radial loads.

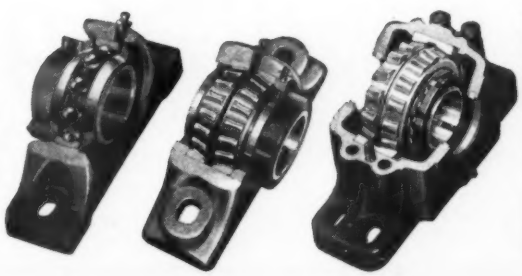
▶ **LINK-BELT service**
which makes bearings quickly available from stocks throughout the country.

May we send you Data Book No. 2550 containing full engineering information? An experienced Link-Belt engineer will be pleased to consult with you and make recommendations, without obligation. Contact the nearest Link-Belt office.

LINK-BELT COMPANY Indianapolis 6, Chicago 9, Philadelphia 40, Atlanta, Minneapolis 5, Houston 1, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8, Johannesburg. Offices, Factory Branch Stores and Distributors in Principal Cities.

11.302

A complete line of bearings is available from stock, throughout the country, in pillow blocks, cartridge, flanged cartridge, flanged, hanger and takeup blocks —also unmounted bearings.



LINK-BELT
BALL & ROLLER
BEARINGS

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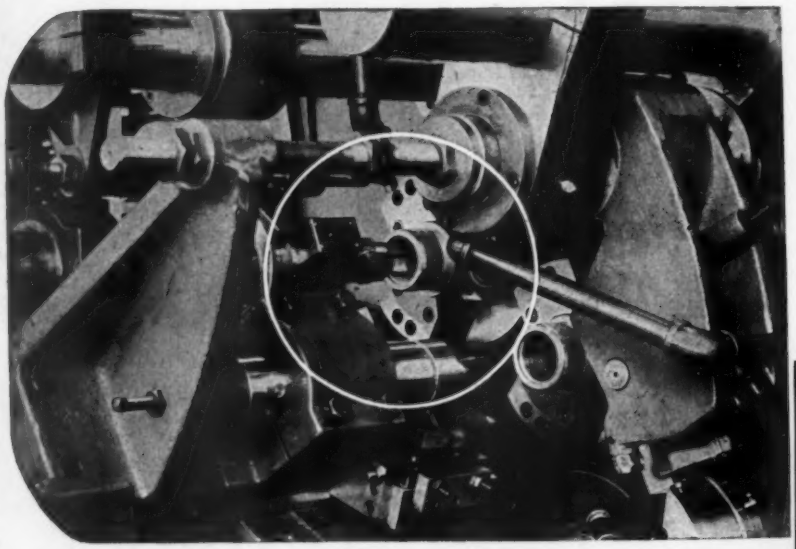
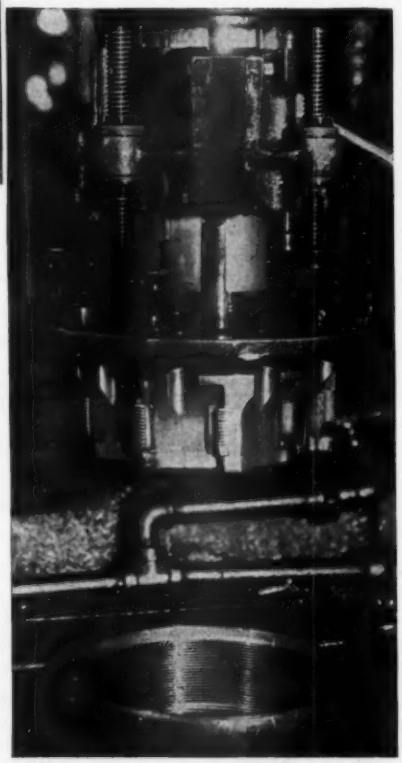
MANY THREAD DIAMETERS
WITH ONE LANDIS TAP



Detachable Heads Cut Wide Range of Internal Threads

The LANDIS Collapsible Tap is a many-purpose tool—yet a single-purpose tool. The versatility of the LANDIS Tap enables it to handle a wide variety of jobs—yet it handles each job as though it were a specially-designed tool.



WIDE THREAD CAPACITY

The ability to cut thread diameters of varying sizes is an outstanding feature of all LANDIS Taps. The thread-cutting head is detachable and tap heads of various sizes and capacities can be used interchangeably on the same tap body. This design makes it possible to cut an unusually-wide range of internal thread sizes with a minimum tool investment. For instance, the 5ALT Tap will cut threads from 1 5/8" to 6 5/8" in diameter.

EASY REMOVAL FROM WORK

LANDIS Taps are constructed with a built-in **collapsing** action. Chasers drop free from the work into the tap head at the completion of the thread. The tap can be removed directly without "backing out," thus saving labor time and chaser wear, and reducing the number of torn threads.

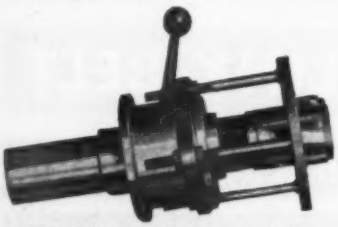
INTERNAL TAPERED THREADS

LANDIS Taps are of two types—the ALT for parallel threads—and the LL for tapered threads. The LL Receding Chaser Collapsible Tap is especially designed to cut API Standard threads in any machineable material well within all required tolerances. This tap features a new receding action—a fulcrumed lever—which gives a positive receding movement to the chasers and allows precision thread tapers. The low cutting strains thus obtained lengthen chaser life and improve thread accuracy and finish.

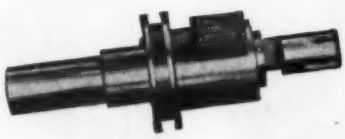
GENERAL FEATURES

LANDIS Taps can be used as stationary or rotary taps, and can be quickly converted from one type to the other. Left-hand threads may be cut with the same tap bodies, using left-hand tap heads. All taps have a fine size adjustment which allows compensation for wear and regrinding, and the style LL Tap can be adjusted to compensate for slight errors in taper.

Consider the money-saving features of LANDIS Taps in cutting internal threads in your plant. Write for Bulletins G-94 and G-95.



ALT Collapsible Tap arranged for use as a Stationary Tap.



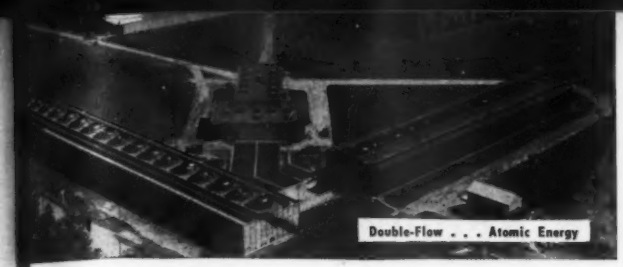
LL Receding Chaser Collapsible Tap arranged for use as a Rotary Tap.

LANDIS MACHINE COMPANY

WAYNESBORO • PENNSYLVANIA

THREADING MACHINERY—THREAD CUTTING DIE HEADS—COLLAPSIBLE TAPS

Represented in the Domestic Oil Fields by: **Colcord-Wright Machinery & Supply Co., St. Louis, Mo.; C. J. Harter Machinery, Houston, Texas; Frederic-Baker Co., New Orleans, La.; Moore Machinery Co., Los Angeles and San Francisco, Calif.; Hendrie & Bolthoff Mfg. & Supply Co., Denver, Colo.**


Double-Flow . . . Atomic Energy

Double-Flow . . . Natural Gasoline

WHAT IS YOUR COOLING PROBLEM?

Spray Pond . . . Refinery

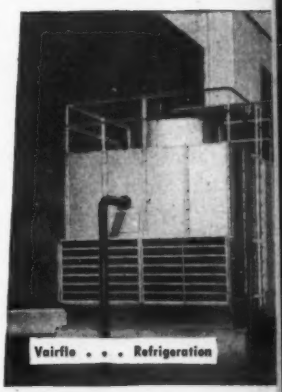
IS IT COST? Cooling towers or DriCoolers can have a low first cost with higher operating cost and vice versa. Or, you can get an economical combination of both. Marley application engineers have a complete line of units to select from and the "know-how" to help you make the best selection for your purpose.

Conventional . . . Pipe Line

IS IT SPACE? Marley equipment may be installed indoors or outdoors. Units are available with large base area and low height to give light loading per square foot or with small base area and greater height to fit in small area.

DriCooler . . . Diesel Cooling

IS IT TEMPERATURE? Usually, it is not economical to cool lower than a 5F approach to the wet bulb. However, in Marley cross-flow towers a quantity of water at wet bulb temperature may be obtained without added cost. For high level cooling, the DriCooler is applicable.


Vairflo . . . Refrigeration

IS IT LOCATION? Extreme temperatures, cold or hot, dust, wet bulb, altitude, brackish water, wind, storm conditions, or lack of proper water supply are problems that must be considered. Marley has a unit to fit any geographical condition.

IS IT APPEARANCE? Marley has a wide range of designs that will blend with any building architecture. Or even become a part of the building itself. Marley engineers can help your architect give you a good looking as well as efficient installation.

Double-Flow . . . Power

These are only a few of the problems you may face in the selection of a cooling tower or DriCooler. No matter what the problem, Marley Application Engineers have the answer to help you invest your dollars wisely and profitably.

DriCooler . . . Gas Cooling

MARLEY

ual Draft . . . Air Conditioning

OG-11

Write, Wire or Phone The Marley Company, Inc., Kansas City 15, Kansas.

Name _____ Title _____

Company _____

Address _____

City _____ Zone ____ State _____

☐ Please send "What's Your Cooling Tower IQ"

☐ Our Cooling Problem is _____

Aquatower . . . Air Conditioning

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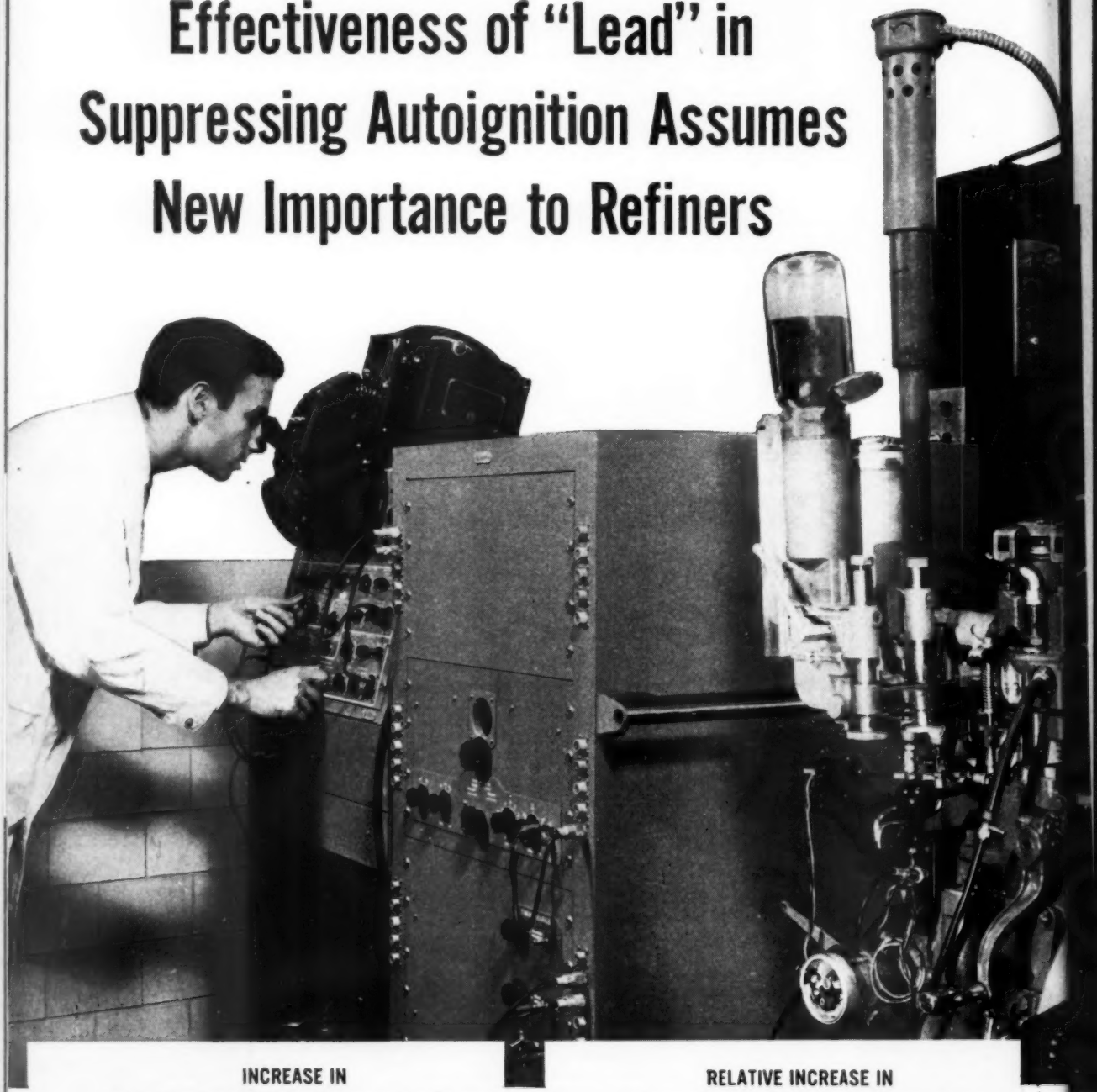
Effectiveness of "Lead" in Suppressing Autoignition Assumes New Importance to Refiners



INCREASE IN
AUTOIGNITION-LIMITED COMPRESSION RATIO
FROM ADDITION OF 3 CC TEL PER GALLON

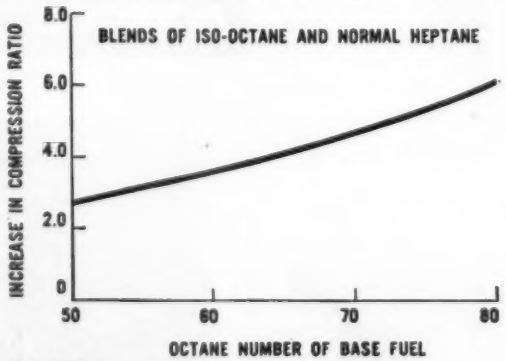


CHART 1.

RELATIVE INCREASE IN
AUTOIGNITION-LIMITED COMPRESSION RATIO
FROM ADDITIONS OF TETRAETHYLLEAD

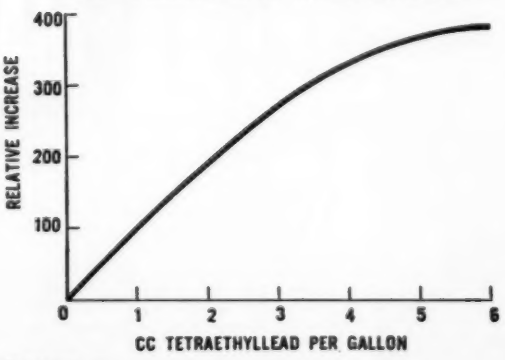


CHART 2

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That tetraethyllead is an effective agent for reducing the tendency of fuels to autoignite was demonstrated by the Ethyl Laboratories as early as 1935. Since that time, this original knowledge has been expanded by a continuing research program on the effectiveness of tetraethyllead in suppressing autoignition in all types of fuels and engines.

The most significant fact disclosed by recent research is that the effectiveness of tetraethyllead in controlling autoignition increases both as the antiknock quality of the base gasoline is improved and as the concentration of tetraethyllead is increased.

An engine was driven at 900 revolutions per minute with greatly retarded ignition. The compression ratio was slowly increased until firing was initiated by autoignition of the fuel. The compression ratio was then reduced slightly until firing ceased. This value was considered to be the limiting compression ratio imposed by autoignition.

On this basis, when the base fuel was a 50-50 blend of iso-octane with normal heptane, the addition of 3 cc of tetraethyllead per gallon of fuel enabled the engine to operate without autoignition at 2.6 ratios higher compression. When the base fuel was an 80-20 blend of iso-octane with normal heptane, an increase of 6.1 ratios was permitted as shown in Chart 1.

2nd and 3rd cc of lead highly effective

The high effectiveness of the second and third cc of tetraethyllead in the suppression of autoignition is shown in Chart 2. Two cc are almost twice as effective as one cc; three cc are 2.7 times as effective as one. Additions of tetraethyllead beyond 3 cc per gallon also have a high effectiveness in contrast to the smaller contributions made in raising octane number.

Studies were also made on the effect of tetraethyllead in suppressing the after-running which sometimes occurs when the ignition is turned off. An engine having variable compression ratio was operated with normal ignition at 900 revolutions per minute and full throttle. The compression ratio was increased until, as the engine decelerated to rest after the opening of the ignition switch, it was on the verge of after-firing.

On this engine, the effect of the concentration of tetraethyllead in the fuel on the maximum permissible compression ratio without after-running was made at cylinder jacket temperatures of 212°F and 300°F (Chart 3). The effectiveness of the higher concentration of tetraethyllead, up to 5 cc per gallon is clearly shown.

Tetraethyllead—a double value

For many years the trend in the design of engines for use in ground vehicles has been toward higher compression ratios. This trend, which has raised the temperatures of compression in engine cylinders to values more nearly approaching the self-ignition temperature of the fuel, seems likely to continue—thus requiring even more consideration of autoignition.

The data show that tetraethyllead offers the refiner—and the eventual user of his gasoline—a double value. It is effective in suppressing autoignition as well as knock. Both of these contributions will have increasing importance to refiners in the future.

EFFECT OF TETRAETHYLLEAD ON MAXIMUM COMPRESSION RATIO WITHOUT AFTER-FIRING

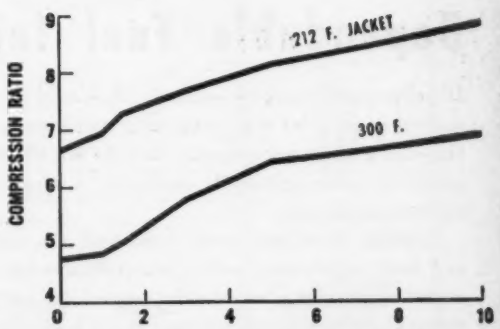


CHART 3

Over 400 specialists working full time on fuel and engine developments

ETHYL CORPORATION
RESEARCH LABORATORIES

DETROIT, MICHIGAN
1600 West Eight Mile Road

SAN BERNARDINO, CALIFORNIA
2600 Cajon Road

ETHYL
ETHYL CORPORATION

XUM

What *important* thing

was necessary

to change THIS

On mountainous terrain of a major southern road, 16 4-unit Diesels now handle the tonnage formerly hauled by 100 of the road's heaviest steam locomotives.

to THIS

Dependable Fuel Injection

Diesel power was already *available* when most of the steam locomotives in use today were being built. But it was a sleeping giant. One vital element was necessary to make this efficient, economical source of power universally applicable — *dependable solid fuel injection equipment.*

American Bosch pioneered in this field. Constant development and field engineering, meticulous craftsmanship and precision manufacture, and a world-wide network of authorized service stations have maintained American Bosch leadership . . . and given owners of American Bosch-equipped engines advantages no maker or user of Diesels can afford to overlook.

1. Development and Field Engineering.

American Bosch engineering departments and laboratories work constantly to improve existing products, develop new ones such as the revolutionary single plunger multi-cylinder PSB Pump. American Bosch field engineers work hand in hand with engine and equipment manufacturers — from original design to test models and actual field operation.

2. Precision Manufacture.

The knowledge and craftsmanship that made solid fuel injection a reality . . . plus engineering research, proven techniques, unparalleled production and testing facilities (many of them initiated and developed here) . . . insure uniform adherence to the highest standards of accuracy and performance.

3. Service Organization.

In many U.S. cities and at strategic points throughout the world, American Bosch maintains an ever-growing network of authorized service stations. Staffed by personnel trained to factory standards, with factory-designed and built testing equipment, they are prepared to render efficient and reliable service whenever needed.

American Bosch

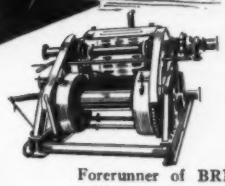
Dependable Fuel Injection for the Diesel Industry

AMERICAN BOSCH CORPORATION, SPRINGFIELD 7, MASS.

Magnetos • Generators • Voltage Regulators • Ignition Coils • Electric Windshield Wipers • Diesel Fuel Injection Equipment

BREWSTER N-7 DRAWWORKS

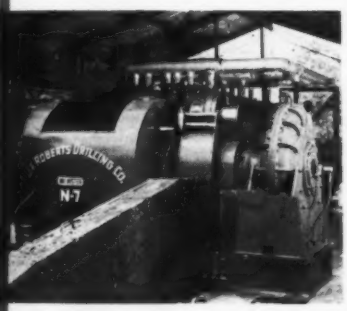
FOR DRILLING TO . . . 8,500'



Forerunner of BREWSTER drawworks is the Early 1932 Model—heavy duty winch equipped with line shaft that could drill 3,000'

. . . BUILT WITH THE *E-FACTOR* . . . EXPERIENCE

THERE IS A REASON WHY THE BREWSTER N-7 DRAWWORKS IS TOP CHOICE . . . It has power . . . portability . . . economy . . . and MORE. It has 40 years experience wrapped-up inside. Back in 1910 the industry, still in short pants, had respect for Brewester design and fine drilling equipment because . . .



BREWSTER N-7 drawworks, 600 h.p. transmission. Has four forward speeds, one reverse, makes eight drum speeds and four Rotary speeds.

"There's no 30 to 40 minutes 'shut - down - time' to re-oil and lubricate a Brewster N-7, my choice for a drawworks with speed—built to take it."

Brewster Engineers have been in the past and are today in direct contact with the men that *use* the equipment. With one foot at the drawing board and the other in the field, Brewster Engineers are constantly applying new advanced engineering design to information gathered from the vast experiences of contractors and toolpushers. THAT'S WHY BREWSTER MATCHED DRILLING EQUIPMENT is the best you can buy for

MAXIMUM EFFICIENCY AND PROFIT

The Brewster N-7 is portable • in one operation it can be moved • all friction clutches are accessible from the outside • is easily operated at eight drum speeds • all bearings and chains are oil lubricated • The N-7 has more power than any drawworks in its class • built for safety and economy.

For detailed information write or wire your nearest supply house or—

THE BREWSTER COMPANY, Inc.

SHREVEPORT, LOUISIANA

SOLD BY:

Apex Equipment Company
Bovaird Supply Company
Industrial Supply Company
Murray Brooks, Inc.

CANADA: Rocky Mountain Supply Co.

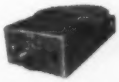
EXPORT SALES: Direct and through legitimate export dealers.

BREWSTER MATCHED Drilling Equipment

MATCHED DRILLING EQUIPMENT

Model 6-S Swivel Oil Lubricated—220 tons.

Model 200 Block, four 36" Sheaves, 200 ton capacity.



Model RS-22 Rotary, 22" Table Opening, 265 ton Dead-load capacity.

24 HOUR FIELD SERVICE — ANYWHERE

SINCE 1910—MANUFACTURERS OF FINE DRILLING EQUIPMENT

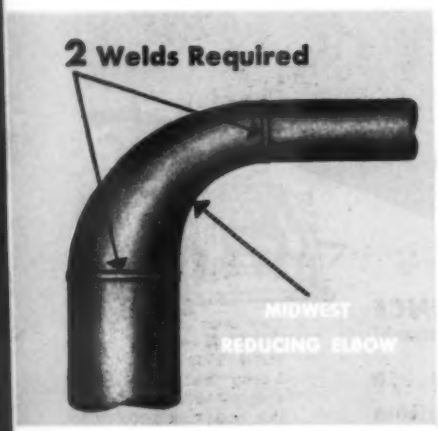
BREWSTER

XUM

SAVE MONEY and get BETTER PIPING by using the

MIDWEST

REDUCING ELBOW



Instead of a Standard Elbow and a Reducer

The Midwest Reducing Elbow saves more than a third of the welding when used instead of a standard elbow and reducer. In addition to a substantial saving in time and money, it provides much neater appearance and insulation is easier. The gradual reduction, smooth curve and absence of abrupt neck reduce the pressure drop and turbulence. Center-to-end dimensions are the same as for ASA standard elbows.

All the advantages of Midwest Standard Elbows are to be found in Midwest Reducing Elbows . . . unusual dimensional accuracy and uniformity, stress relieving, beneficial effect of working metal in compression, etc.

The Midwest Reducing Elbow is only one of many fittings developed by Midwest to reduce the cost and improve the quality of welded piping. You will find it advantageous to get in touch with the Midwest Distributor near you whenever you need welding fittings.

MIDWEST WELDING FITTINGS
Improve Piping Designs and Reduce Costs

90° ELBOWS

REDUCING 90° ELBOWS

45° ELBOWS

LAP-JOINT STUB ENDS

REDUCERS

CAPS

SADDLES

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RETURN BENDS

TEES

LATERALS

CROSSES

REDUCING-ON-RUN TEES

SHAPED NIPPLES

FLANGES

MIDWEST PIPING & SUPPLY COMPANY, Inc.

Main Offices: 1450 South Second Street, St. Louis (4), Mo.

Sales Offices: **New York (7), 30 Church St.**

Chicago (3), 79 West Monroe St. • Los Angeles (33), 520 Anderson St. • Houston (2), 229 Shell Bldg. • Tulsa (3), 533 Mayo Bldg. • South Boston (27), 426 First St. • Distributors in Principal Cities.

XUM

Bulk station operators—BJ engineered this pump to your needs...

For handling all bulk petroleum products except propane-butane

PUMP MAINTENANCE headaches—or a high priced pump investment—may be your problem on bulk station pumping. If so, you'll welcome this new BJ Bulk Station Pump. It's designed to give you a rugged pump that will handle petroleum products without leakage and without servicing headaches—*at a price that will fit your budget.* Here are some of the features of this single stage, single suction TLB model:

NEW BJ MECHANICAL SEAL—protection against leakage plus elimination of frequent repacking.

BILT-ON-CONSTRUCTION—pump and motor are constructed in a single unit on a common shaft.

ALL PARTS ARE STANDARD—if replacement parts are needed there's no costly delay or extended downtime—parts are quickly available from local BJ branches or dealers.

SAFE, DEPENDABLE OPERATION—explosion-proof motor assures safe, trouble-free pumping.

FIND OUT how this newly-designed BJ Bulk Station Pump can simplify your bulk petroleum handling. Ask your local BJ representative for details or use the coupon below.

NEW

BJ

TYPE TLB
BULK STATION
PUMP

CAPACITY DATA

Pump sizes from 1¼" to 3"
Capacities to 600 gpm
Discharge pressures to 100 psi

Byron Jackson Co.
Since 1872
P. O. Box 2017 Terminal Annex, Los Angeles 54, Calif.
OFFICES IN PRINCIPAL CITIES

for more information - send this coupon now...

BJ PUMP DIVISION, Dept. 25

Our job is handling_____ at capacities of_____ gpm and a discharge pressure of_____ psi.

Send me full details on the new BJ Bulk Station Pump to fit this job.

NAME_____

COMPANY_____

ADDRESS_____

CITY_____

STATE_____

No obligation, of course!

Style... Comfort... Economy...

go hand in hand

MANUFACTURERS OF SPECIAL MILLWORK: DISTRIBUTORS OF JOHNS-MANVILLE BUILDING MATERIALS; CURTIS WOODWORK

Over 30 years experience has taught Southern Mill how to manufacture prefabricated buildings that fill the bill for style . . . comfort and economy. STURDY-BILT Houses are built to last, too. They can be transported anywhere, and erected in days instead of weeks. For immediate delivery of any oil field housing you need . . . phone or write today.

STURDYBILT

SOUTHERN MILL & MANUFACTURING CO.

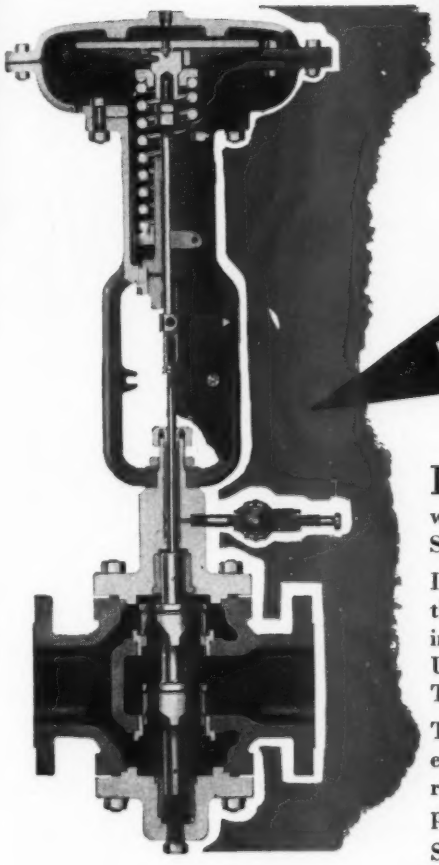
Tulsa, Oklahoma

Prefabricated, Demountable Houses

PREFABRICATED HOME MANUFACTURERS' INSTITUTE phmi

STURDYBILT HOUSES COMPLY WITH COMMERCIAL STANDARD CS125-45 OF THE NATIONAL BUREAU OF STANDARDS FOR PREFABRICATED HOMES

• There are many diaphragm control valves... but



You'll WANT THE

HONEYWELL SERIES "700"

For a diaphragm-operated valve that affords utmost precision in wide band proportional control . . . your best bet is the Honeywell Series "700."

In addition to the usual features you expect to find in a fine valve, the "700" gives you: Pre-molded Neoprene Diaphragm with Rolling Action, Pivot-Mounted Inner Plate and Cradle-Mounted Upper Spring Flange, Duplex Bearing for Stem, One-Piece Bonnet, Top and Bottom-Guided Disc.

The quality of the Series "700" stems from years of research and engineering know-how . . . in designing the right valve, from the right material, with the right specifications for the more complex process applications.

Service, when needed, is available from the Honeywell nationwide network of branch offices and factory-trained field engineers . . . as near to you as your phone. Call in your local Honeywell engineer today . . . for detailed information.

Investigate the Series "700" . . . today . . . write for Bulletin 700-2

Minneapolis-Honeywell Regulator Co., *Industrial Division*, 1906 Windrim Ave., Philadelphia 44, Pa. Offices in more than 80 principal cities of the United States, Canada and throughout the world.

Minneapolis Honeywell

VALVE PRODUCTS

There they go—laying 56 miles of 34-inch pipe line in a month's time! Records fall to the mechanized attack of Bechtel crews who, this year alone, will complete more than 1700 miles of oil and gas pipe lines ranging from 20" to 34" in diameter.

BECHTEL CORPORATION

Los Angeles • **SAN FRANCISCO** • *New York*
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"BUILDERS FOR INDUSTRY"

DESIGN • ENGINEERING • CONSTRUCTION

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Ladish Elbows

...A Complete Size Range Another Reason to Specify *Controlled Quality*

SEAMLESS WELDING FITTINGS

From the small fitting that weighs several ounces to the half-ton giant . . . whatever your fittings requirement, the Ladish line provides you with an unrestricted choice of sizes in a complete range of types, weights and materials. In addition, every fitting offers the added dependability assured by the high manufacturing and metallurgical standards of Ladish Controlled Quality.

THE COMPLETE FITTINGS LINE
PRODUCED UNDER ONE ROOF...ONE RESPONSIBILITY

LADISH CO.

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DISTRICT OFFICES: New York • Buffalo • Pittsburgh • Philadelphia • Cleveland • Chicago
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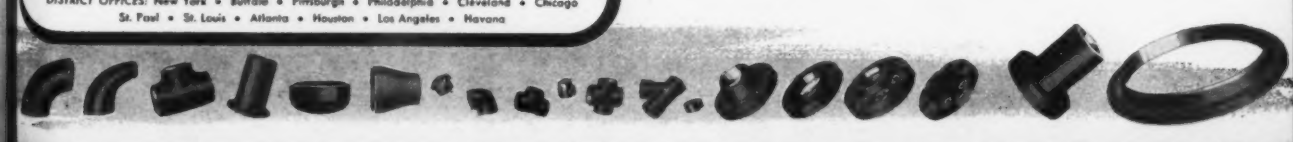

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DAVISON

SYNTHETIC FLUID TYPE CRACKING CATALYSTS

Your requirements for synthetic fluid type cracking catalyst can now be supplied by Davison in either microspheroidal or ground form. Both are available in various grades . . . and are backed by Davison's experience as producers of catalysts since the installation of the *first* fluid cracking catalyst plant.

To meet the needs of your specific processes, Davison will give you complete cooperation in the development and production of special catalysts.

*T.M.T.D.C.C.

Progress through Chemistry

THE DAVISON CHEMICAL CORPORATION

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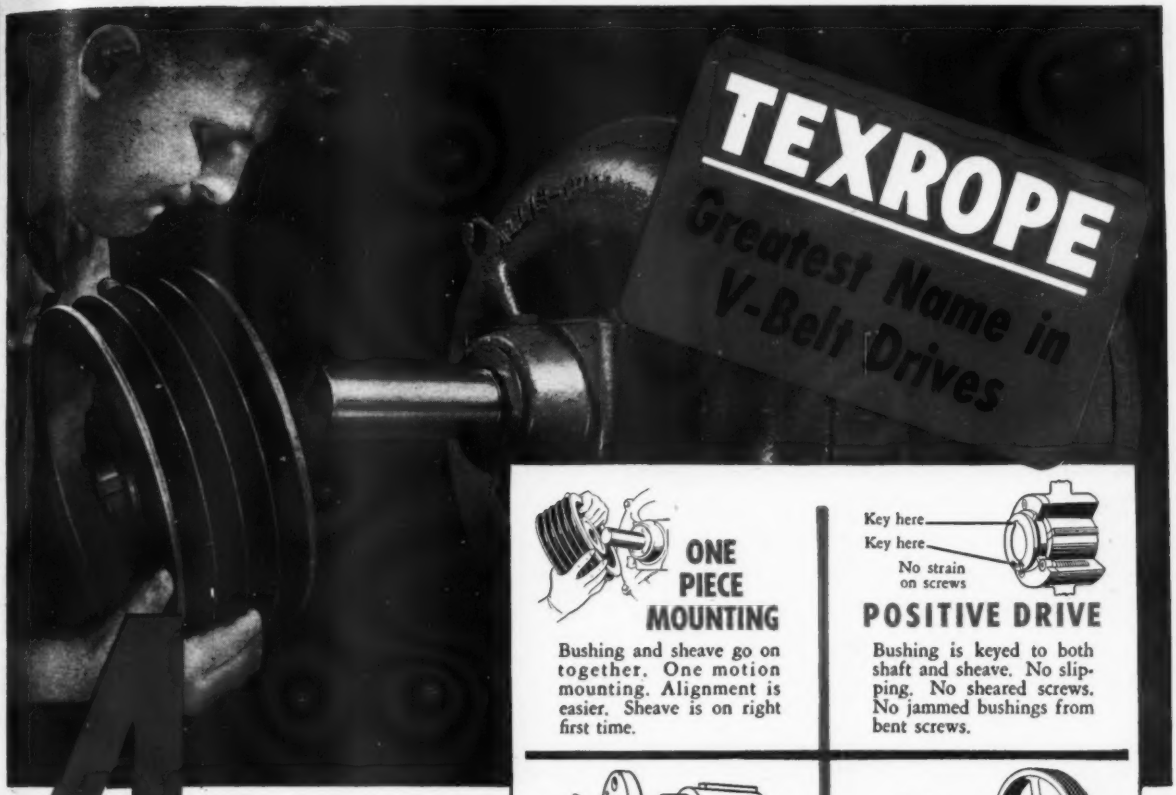


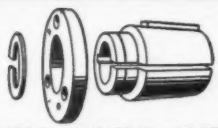
4 BIG ADVANTAGES!

ONE PIECE MOUNTING

Bushing and sheave go on together. One motion mounting. Alignment is easier. Sheave is on right first time.

POSITIVE DRIVE

Bushing is keyed to both shaft and sheave. No slipping. No sheared screws. No jammed bushings from bent screws.



FULL CIRCLE GRIP

Bushing split full length with separate collar. Grips shaft full length around full diameter. No forcing or distortion. Grip easily broken. No hammering.

WIDE SIZE RANGE

Magic Grip sheaves are available from 3" pitch diameter up. Style NC bushing for smaller sizes and Style C bushing for larger sizes.

MAGIC GRIP SHEAVE

YOU CAN MOUNT a *Magic Grip* sheave faster than any other sheave you can buy . . . and demount it just as fast. When you mount a *Magic Grip* sheave it runs true. It will not slip or jam. It always comes off easily.

Even if you don't change sheaves often, you should have *Magic Grip* sheaves on every drive to eliminate the possibility of shaft and bearing damage when ordinary sheaves are hammered or pried on or off.

WIDEST V-BELT LINE

Get everything you need for your V-belt drives from one reliable source. *Texrope* offers the broadest line of V-belts, standard and variable speed sheaves and speed changers in the industry. And you also get the extra engineering skill that comes from having more industrial V-belt installations than any other manufacturer.

Get your copy of the 144 page *Texrope* Pre-Engineered Drive Manual from your A-C Authorized Dealer or Sales Office or write for Bulletin 20B6956.

A-3022

ALLIS-CHALMERS, 1059A SO. 70 ST.
MILWAUKEE, WIS.

Texrope and *Magic Grip* are Allis-Chalmers trademarks.

Sold . . .
Applied . . .
Serviced . . .

by Allis-Chalmers Authorized Dealers, Certified Service Shops and Sales Offices throughout the country.

MOTORS — ½ to 25,000 hp and up. All types.

CONTROL — Manual, magnetic and combination starters; push button stations and components for complete control systems.

PUMPS — Integral motor and coupled types from ¾ in. to 72 in. discharge and up.

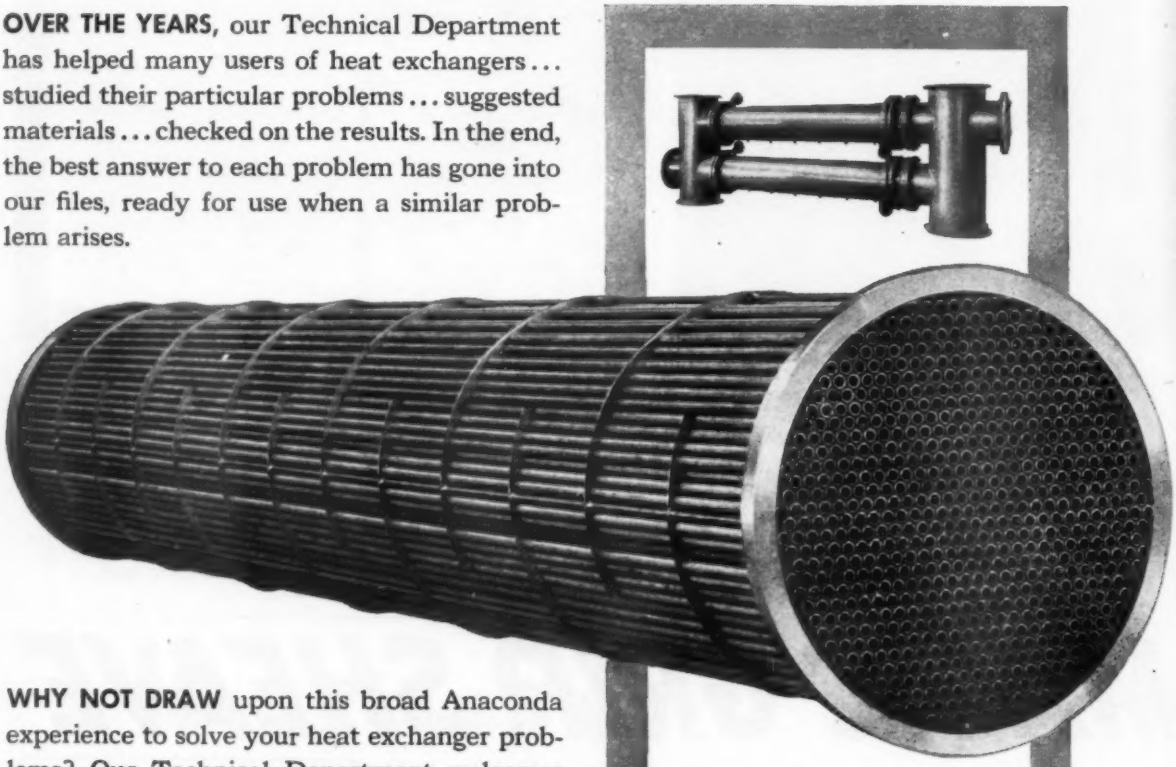
ALLIS-CHALMERS

Is your heat exchanger tube and sheet problem

Different? Tougher?

It may seem so to you—but it may not be so to us!

OVER THE YEARS, our Technical Department has helped many users of heat exchangers... studied their particular problems... suggested materials... checked on the results. In the end, the best answer to each problem has gone into our files, ready for use when a similar problem arises.



WHY NOT DRAW upon this broad Anaconda experience to solve your heat exchanger problems? Our Technical Department welcomes the opportunity to place it at your service. If you don't already have a copy, let us send you "ANACONDA Tubes and Plates for Condensers and Heat Exchangers." Just ask for Publication B-2. The American Brass Company, Waterbury 20,. Connecticut. In Canada: Anaconda American Brass Limited, New Toronto, Ont.

50118

UPPER PHOTO shows Adams two-shell, single stage aftercooler designed to control temperature of compressed air and to condense water and oil vapors present. The condensate is removed by a separator. Built by R. P. Adams Company, Inc., Buffalo, N. Y.

LOWER PHOTO shows tube bundle for aftercooler. ANACONDA Arsenical Admiralty Tubes, Muntz Metal Tube Sheets and Brass Baffles.

For efficient heat transfer **ANACONDA®**

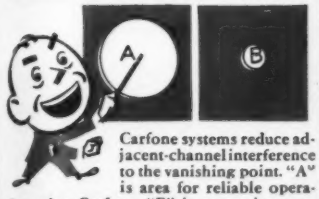
HEAT EXCHANGER TUBES

The RCA Carfone 152-174 Mc.

More than meets all FCC requirements

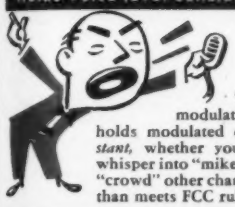
Complete with loudspeaker, controls, microphone, antenna, and self-contained transmitter, receiver, and power supply.

Better service over wider area



Carfone systems reduce adjacent-channel interference to the vanishing point. "A" is area for reliable operation using Carfone. "B" is area using conventional type equipment.

Holds voice level constant



Transducer modulation control holds modulated output *constant*, whether you shout or whisper into "mike." Does not "crowd" other channels. More than meets FCC rules.

Makes mounting easy

"Sandwich Case" construction makes installation easy—even in the "tight" spots. No mounting brackets needed to raise a CARFONE for servicing.

Suppresses "unwanted" radiation

Spurious emission way down on *all* frequencies—not just in the band. More than meets FCC rules for reducing interference with other services.

Bars interference

Low spurious response in CARFONE receiver does away with interference from transmitters on other frequencies.

Why you will prefer the RCA CARFONE

BECAUSE the RCA CARFONE enables systems cars and trucks to operate *without interference* over greater geographical area than was heretofore believed possible.

BECAUSE the RCA CARFONE can be installed almost anywhere. In passenger vehicles it can be installed on the fire wall . . . or on the shelf behind the back seat . . . or in the rear deck. In trucks it can be mounted on the wall of the driver's compartment, in the freight section, in truck side lockers.

BECAUSE the RCA CARFONE requires no extra space for opening sliding drawers—requires no double mountings—uses no junction boxes.

' ' '

For complete details . . . or for consulting help on your radio system . . . write **Dept. 141G.** No obligation, of course.

MOBILE COMMUNICATIONS SECTION

RADIO CORPORATION of AMERICA

ENGINEERING PRODUCTS DEPARTMENT, CAMDEN, N.J.

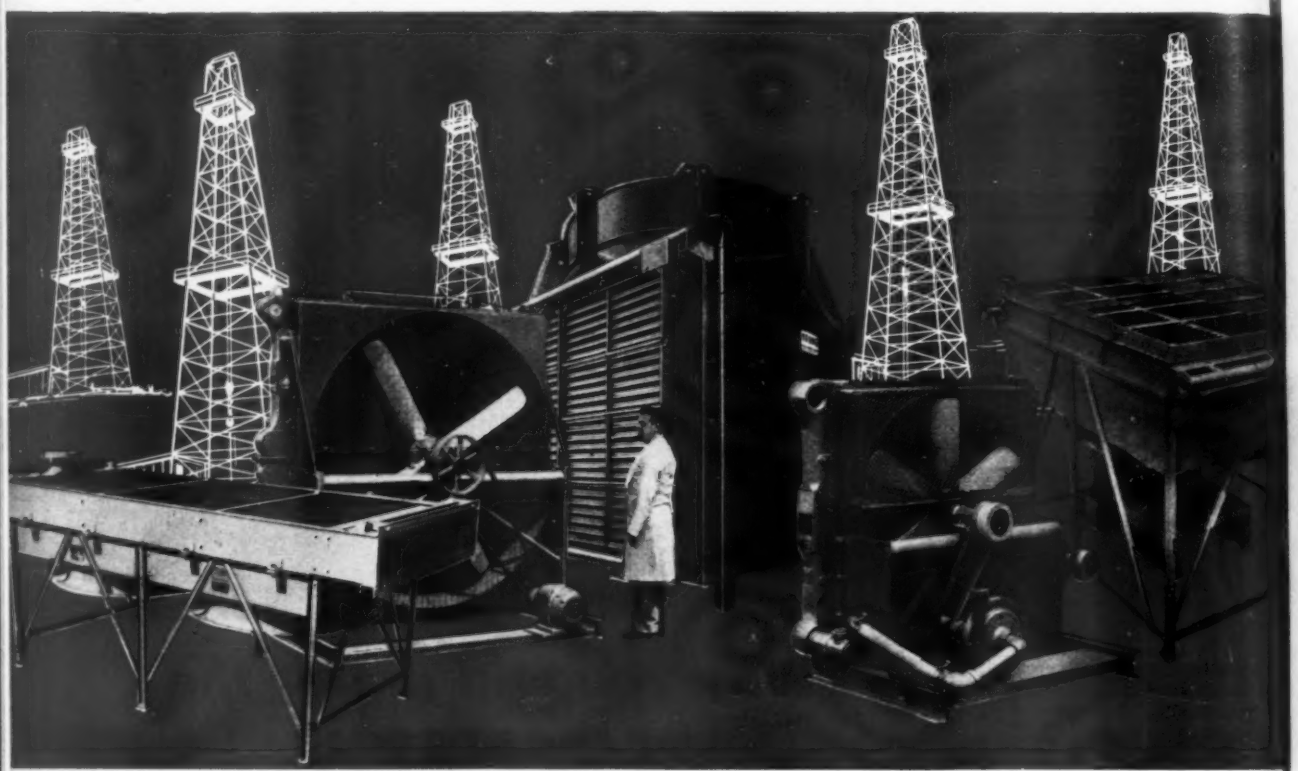
In Canada: RCA VICTOR Company Limited, Montreal

XUM

TAILOR-MADE FOR THE PETROLEUM INDUSTRY

The Young Line, from start to finish, is built for your use. Every product is engineered by Heat Transfer Specialists, men with more than two decades actual field experience. Every piece of equipment is manufactured to rigid standards of quality in the Young plants . . . designed for the large-scale production of all types of coil structures. For your convenience, standardized units for routine cooling and condensing are stocked at the plants and field offices.

Young feels its responsibility starts with the specification and continues long after the installation. Nearby trained field experts are available for consultation at any time. Call or write your nearest Young Representative; he will be pleased to give you full details.



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HEAT TRANSFER PRODUCTS FOR INDUSTRIAL AND AUTOMOTIVE APPLICATIONS

HEATING, COOLING, AND AIR CONDITIONING PRODUCTS FOR HOME AND INDUSTRY

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YOUNG RADIATOR COMPANY, Dept. 200-L,

GENERAL OFFICES: RACINE, WISCONSIN
PLANTS AT: RACINE, WIS., and MATTOON, ILL.

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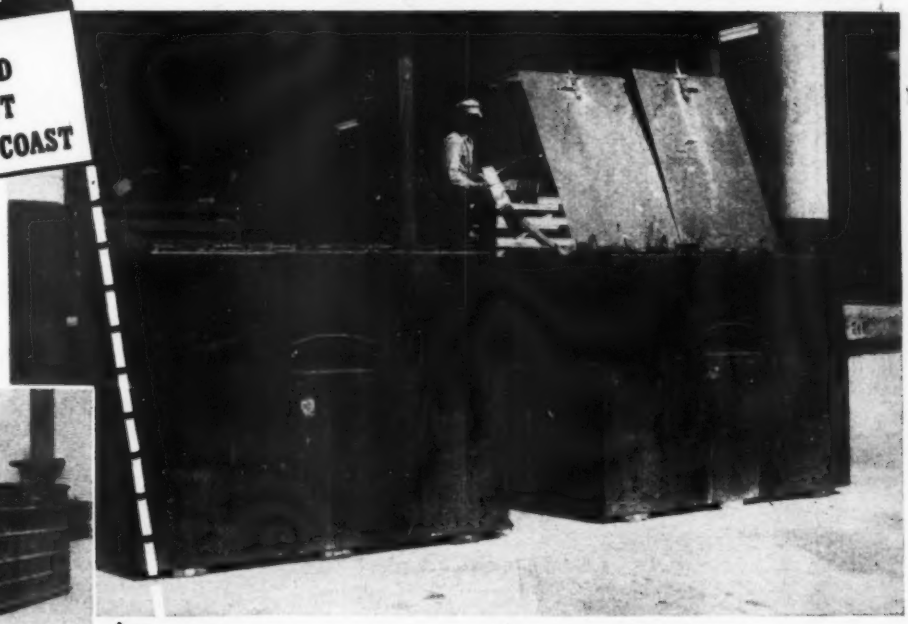
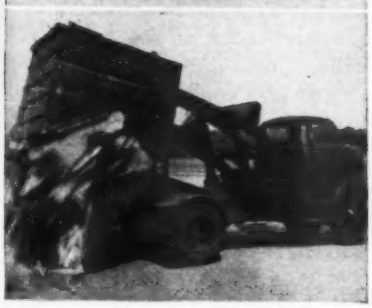
★ DEMPSTER DUMPSTER SYSTEM

SERVING COST-MINDED MANAGEMENT FROM COAST TO COAST

. . . handling bulk materials of every description at phenomenal savings





★ COLGATE PALMOLIVE-PEET CO. CPP QUALITY PRODUCTS SINCE 1806

– recognized across the nation

. . . Colgate-Palmolive-Peet Company, well known for sound management, uses the Dempster-Dumpster System.

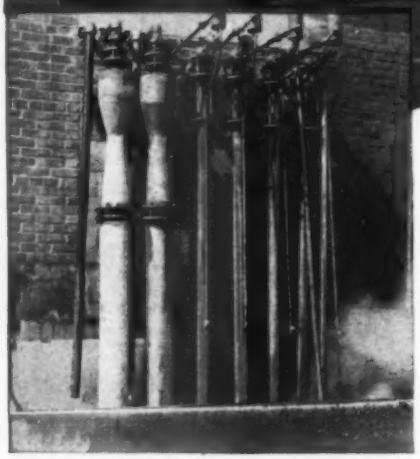
Colgate-Palmolive-Peet Company is among the hundreds of well managed manufacturers, both large and small, who use the Dempster-Dumpster System of bulk materials handling . . . the system recognized across the nation for its efficiency and ability to reduce costs.

You will cut cost of equipment and operation . . . you will eliminate standing idle time . . . you will eliminate re-handling of materials . . . and you will increase efficiency and good "housekeeping" by installing the Dempster-Dumpster System in your plant now! In this system, one truck-mounted Dempster-Dumpster services any required number of detachable containers—and each suited to the particular materials handled—be they bulky, light or heavy . . . solids, liquids or dust . . . trash or rubbish. Large photo above shows how containers are placed at convenient materials accumulation points and are preloaded, in this case, with waste materials. With only one man, the driver, the truck-mounted Dempster-Dumpster picks-up, hauls and dumps one pre-loaded container after another, as illustrated in three photos at left. It will pay you to investigate the Dempster-Dumpster System now! A product of Dempster Brothers, Inc.

One Dempster-Dumpster Services All Containers. . . All Designs. . . All Sizes

DEMPSTER BROTHERS, 5110 Dempster Building, Knoxville 17, Tennessee

THIS ScrubTeam BEAT THE FUME AND DUST MENACE



The four 48" SK Fume Scrubbers in the top view are used for absorption of sulphurous fumes in an oil refinery.

The two 6" SK Fume Scrubbers in the lower photo are made of Haveg and handle hydrochloric acid vapors at the plant of a large producer of synthetic materials.

OBNOXIOUS, contaminating fumes and vapors—heavy, corrosive and dangerous dusts—*need not* create a major plant problem, *can* be effectively and economically controlled.

To meet and master varying conditions in the battle against this menace, SK manufactures a wide range of types and sizes of Vapor Condensers or Fume Scrubbers—a team specially designed for such service.

If your conditions are such that fumes or dust can be knocked down and scrubbed with water or other liquid, an SK Fume Scrubber can do the job economically. Simple in construction, these units produce their own draft and give complete mixing without possibility of by-pass.

Standard and Special Fume Scrubbers are available in various materials such as cast iron, welded steel plate, Haveg, stoneware, hard lead and other corrosion resistant alloys or chemical resistant linings. Rubber lining is available with cast iron or welded steel plate.

For complete information, write for Bulletin 4-R. If your problem is immediate, call or teletype.

SCHUTTE and KOERTING Company

Manufacturing Engineers

1175 THOMPSON ST. • PHILADELPHIA 22, PA. • TWX No.: PH 782

JET APPARATUS • HEAT TRANSFER EQUIPMENT • STRAINERS • CONDENSERS AND VACUUM PUMPS • OIL BURNING EQUIPMENT • ROTAMETERS • FLOW INDICATORS • RADIAFIN TUBES • VALVES • SPRAY NOZZLES AND ATOMIZERS • GEAR PUMPS • DESUPERHEATERS

EASY MAINTENANCE

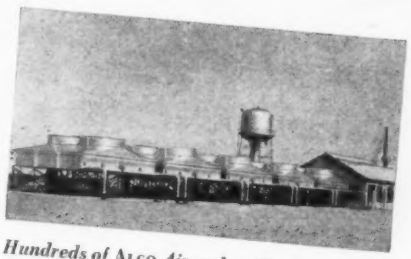
is the pay-off with ALCO AIRCOOLERS

Experienced maintenance crews like ALCO **Aircoolers.** They will tell you that *all parts*—drives, fans, cooling surfaces, etc., are easy to reach and simple to maintain on these sturdy units.

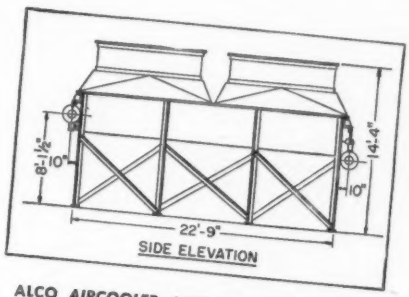
This time-saving advantage coupled with other cost-cutting "big 5" features makes ALCO **Aircoolers** the key to efficient heat exchange—especially where there is a lack of good water, or an expensive pumping problem is involved.

Such benefits are possible because ALCO design is based on years of in-the-field experience and years of engineering development in the production of *all* types of heat exchangers. Put the "big 5" to work in your plant. Write now for the free ALCO **Aircooler** booklet, or see your nearest ALCO Sales Engineer at Chicago, Cleveland, Houston, Kansas City, Los Angeles, New York or Tulsa. Plants at Dunkirk, N. Y. and Beaumont, Texas.

ONE AIRCOOLER FROM THE ALCO LINE



Hundreds of ALCO *Aircoolers like those shown are now in use cooling lube-oil, jacket-water, gas, vapors, etc.*



ALCO *AIRCOOLER*, MULTI-BUNDLE MODEL T-4
CONDENSED SPECIFICATIONS

No. of tubes per row—30/29 (staggered pitch).

No. of bundles per unit—Four.

Fans—Two, 10 ft. or 11 ft.

Drive—Electric Motor, V-belt or Gear Drive.

Face Area—540 sq. ft.

ONLY ALCO HAS THE BIG 5

1 Low Cost
2 Flexible Design
3 Efficient Performance
4 EASY MAINTENANCE
5 Quick Installation

ALCO

ALCO Products Division
AMERICAN LOCOMOTIVE COMPANY

***In step with tomorrow*—ALCO AIRCOOLERS, Heat Exchangers, Evaporators, Feedwater Heaters, Pressure Vessels, Pipe**

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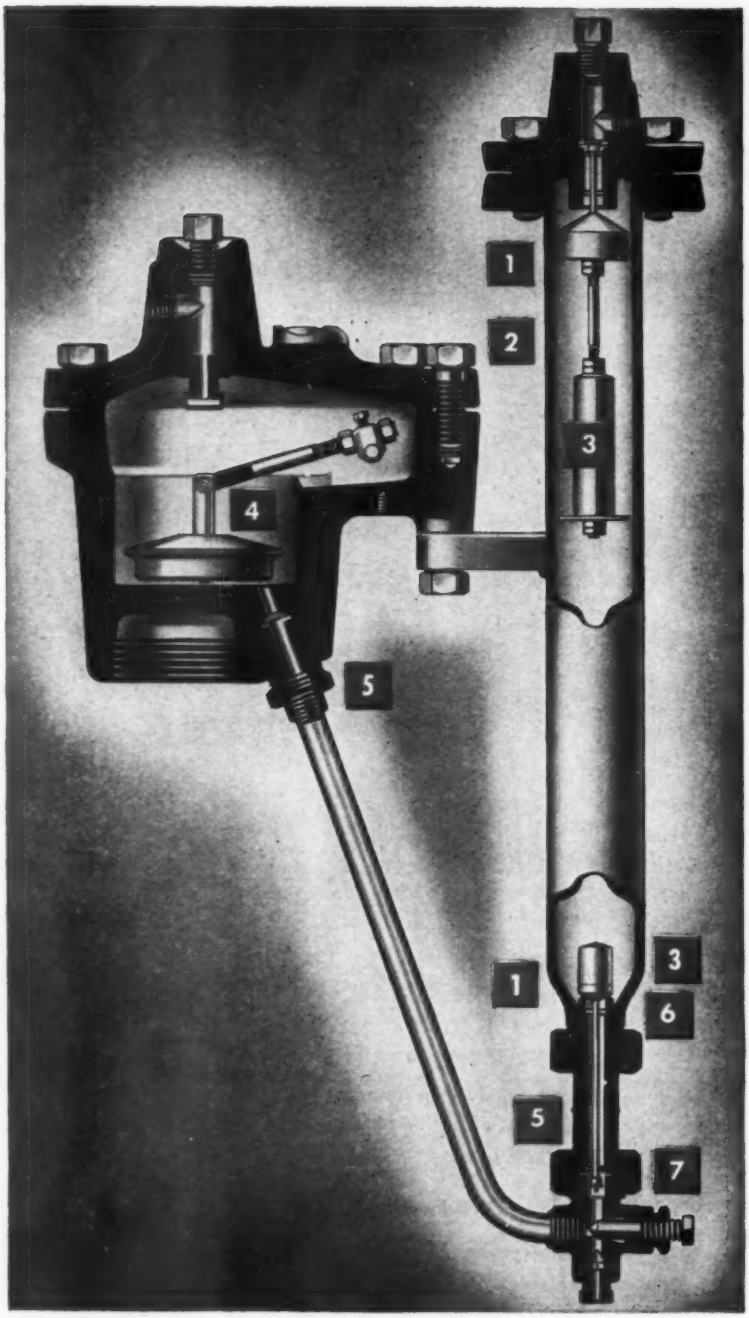


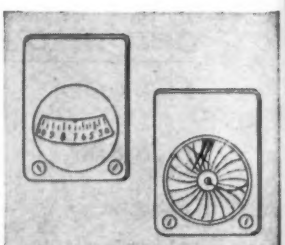
A NEW C
for 1500 p.

1. New Mercury Check Valves Stainless Steel Seats
2. Extended Hi-Side. Prevents Loss of Mercury on Reverse Flows
3. Plastic Check Valve Floats
4. Float in Low Side for Convenient Adjustment
5. Union Type Connections for Interchangeability of Range Tubes
6. Swaged Hi-Side Tube
7. New Pulsation Dampener

HIGH PRESSURE IRONCASE METERS
(Bulletin EG-40)

RELIANCE CBVA MOTOR VALVES
(Bulletin 50-A)

DRY TEST METERS
(Bulletin AG-3)



PNEUMATIC TRANSMITTERS AND RECEIVERS
(Bulletin CT-49)

ORIFICE METER

p.s.i. Working Pressure

Among the important operating and service improvements embodied in the American METRIC A-88 Series Orifice Meters are the following:

The mercury float is in the low side chamber, which permits cleaning and calibration with low side cover removed

Union type seal tube connections permit interchanging 20", 50", 100" and 200" ranges. Other ranges up to 800" available

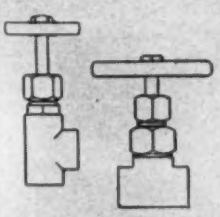
Over-range protection is provided by submerged check valve with long guided stem and stainless steel seat

Under-range protection is provided by check valve with stainless steel seat and plastic float in extended high-side chamber

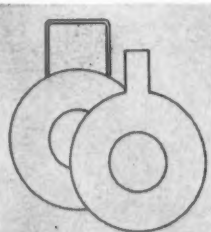
A new Teflon sealed stuffing box with monel shaft requires no grease or other lubrication furnished upon request

A-88 Series Orifice Meters will handle tough measurement problems. They are rugged, yet simple. They are particularly suitable for applications which must function properly where service inspections may be few and far between. They maintain the American Meter Company tradition of "*sustained accuracy at lower cost.*" Write for Bulletin.

American Meter Company
RECORDING ORIFICE METER
Diff. Range Inches of Water 10—20—50—100—200
Pressure Springs available for all applications



NEEDLE VALVES, SCREWED AND UNION BONNET
(Specification Sheet)



ORIFICE PLATES AND ORIFICE FLANGES
(Bulletin EG-2)

AMERICAN METER COMPANY
(INCORPORATED ESTABLISHED 1836)

60 East 42nd Street • New York 17, N. Y. • Albany • Alhambra
Atlanta • Baltimore • Birmingham • Boston • Chicago
Dallas • Denver • Erie • Fort Lauderdale • Houston
Joliet • Kansas City • Los Angeles • Minneapolis • Odessa
Philadelphia • Pittsburgh • San Francisco • Tulsa
In Canada—Canadian Meter Co., Ltd., Hamilton, Ontario

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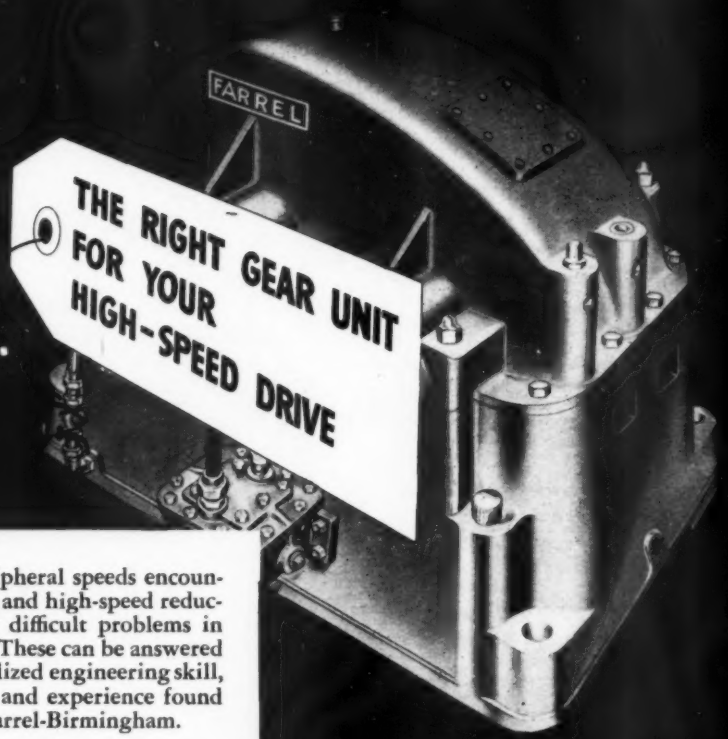
HOW TO BE SURE YOU GET . . .



The extremely high peripheral speeds encountered in speed increasing and high-speed reducing applications present difficult problems in design and construction. These can be answered only by the kind of specialized engineering skill, manufacturing facilities and experience found at the Buffalo plant of Farrel-Birmingham.

SPEED INCREASING UNITS—Farrel Type SI units were the first speed increasers to be developed in a standard series for pipe line pumping service. That was eighteen years ago, and all of the original units, as well as those installed since, are still in operation.

The modern SI line consists of 49 standard sizes with speed ratios ranging from 1:1 to 12:1. For higher ratios, units using two sets of gears are supplied with ratio range from 12:1 to 40:1. Two-pinion units, designed to transmit power from a single engine to two pumps, are also available.

SEMI-HIGH SPEED UNITS—When requirements fall between the range of Type SI units and standard commercial speed reducers, Farrel semi-high speed units are recommended. These units are designed for pinion speeds up to 3600 RPM and gear pitch line velocities up to 4000 FPM.

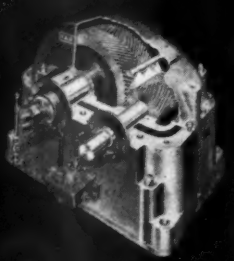
Farrel engineers will be glad to help you select the right gear unit for your high-speed application. Write for further information about any of the types mentioned.

FARREL-BIRMINGHAM COMPANY, INC., ANSONIA, CONN.
Plants: Ansonia and Derby, Conn., Buffalo, N. Y. *Sales Offices:* Ansonia, Buffalo, New York, Boston, Pittsburgh, Akron, Cleveland, Cincinnati, Detroit, Chicago, Los Angeles, New Orleans

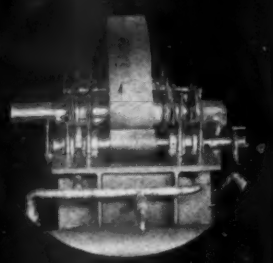
OIL FIELD REPRESENTATIVES:
Hercules-Lupfer Engine Sales Co., 124 N. Boston St., Tulsa 1, Okla.
V. W. Osborne, 822-A M & M Building, Houston 2, Texas

Farrel-Birmingham®

FB-629


STANDARD SI UNIT

DOUBLE STEP-UP UNIT


TWO PINION UNIT

SEMI-HIGH SPEED UNIT

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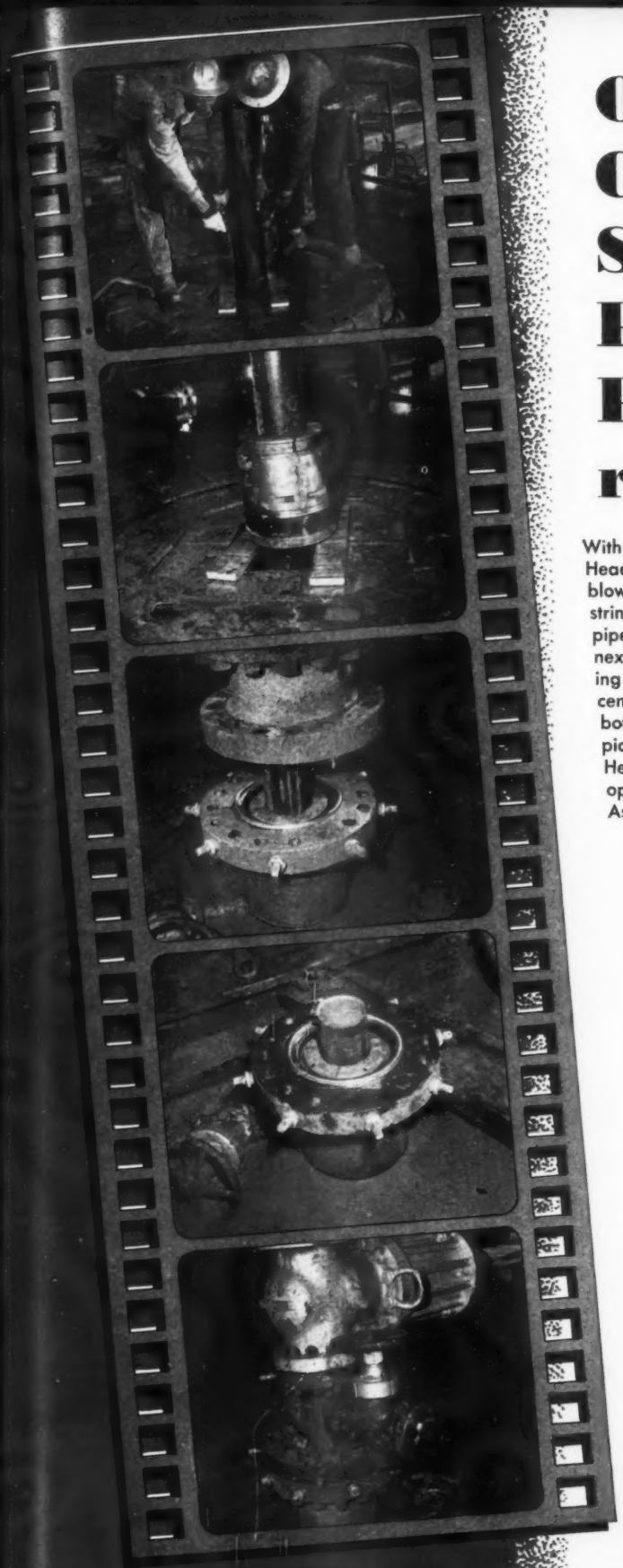
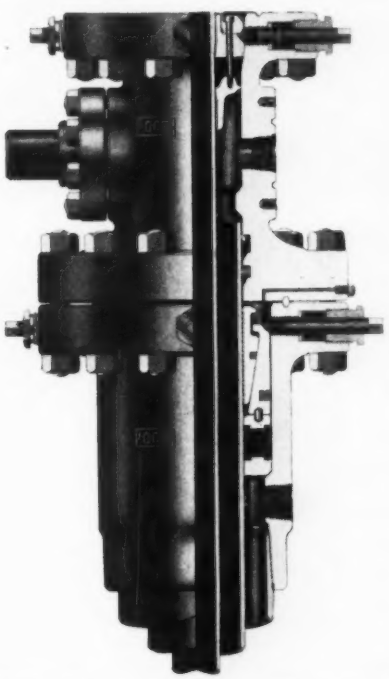


O-C-T C-19 Casing Heads Set, Seal and Protect before Preventers are removed

With the quick setting and automatic sealing O-C-T C-19 Casing Head, your well is closed in positively around the casing before blowout preventers are unflanged. The space between the strings is safely sealed so that blowouts cannot occur while the pipe is being cut off, the blowout preventers set aside and the next head installed. No manual work is required to apply sealing compression to the seal ring. Slips set evenly, automatically centering pipe, and slip tooth pressure is uniform from top to bottom and around the pipe. The entire series of operations pictured at left required to install the O-C-T "C-19" Casing Head is conducted without leaving any remote possibility open at any time for your well to pressure up and blow out. Ask your O-C-T Representative or write for complete details.



Oil Center Tool Co.

P. O. Box 3091, Houston, Texas

Export Representatives: Venezuela, Colombia, Peru, and Ecuador — Berry & Hall, Apartado No. 304, Maracaibo, Venezuela. Sterling Areas—Le Grand, Sutcliff & Gell, Ltd., Southall, Middlesex, England. Address Export Inquiries for All Other Countries to P. O. Box 3091, Houston 1, Texas.

It's the only Casing Head that meets every well completion problem with a single compact model.

OCT PRODUCTS—dependable and available through more than 700 supply store locations.

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FOR LIMITED NPSH APPLICATIONS IN ALL INDUSTRIAL PROCESSES

...AND FOR INSTALLATIONS WHERE FLOOR SPACE IS AT A PREMIUM

THE *Peerless* HYDRO-LINE

ENCASED CLOSE-COUPLED VERTICAL CENTRIFUGAL PUMP

For application to: **Petroleum Refinery Techniques • Line Booster Service • Chemical Processing • Condensate Return Service.**

Especially suited for Pumping: **Hydrocarbons, such as: Gasoline, Propane, Butane, Oils, etc. • Hot or Cold Water • Acids • Bases • Salt Solutions—Mild or concentrated at temperatures from normal to 400° F.**

This successful modification of the Peerless vertical, close-coupled turbine pump, for industrial processes embodies all the exacting design, construction and performance characteristics which have made Peerless the sales leader in the field of vertical turbine pumps. The Peerless Hydro-Line is easy to understand, install, operate and maintain. It has been especially designed for limited space requirements and for limited NPSH applications. Request your copy of Peerless Bulletin B-592 for full details of Hydro-Line design, construction, application and performance.

CHARACTERISTICS AT A GLANCE:

CAPACITIES
Up to 5000 GPM.

HEADS
Up to 1500 feet.

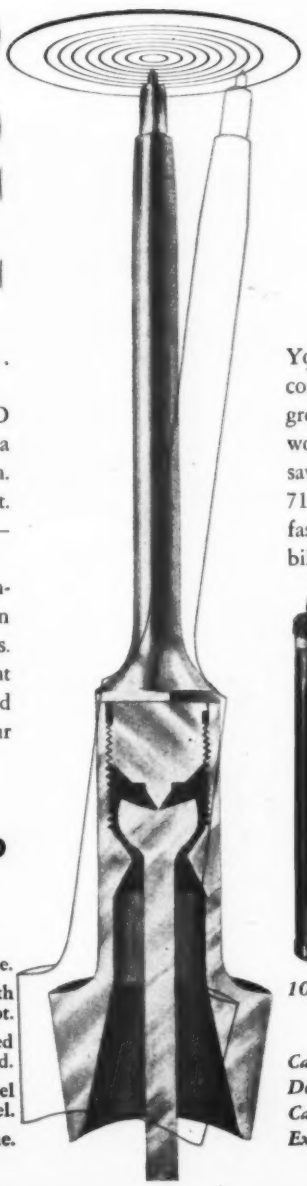
DRIVES
As required; standard vertical, solid shaft, hollow-shaft, or explosion-proof motors; steam turbine.

MATERIALS
Cast iron bowls, bronze impellers, #416 stainless steel shaft, standard; any special materials can be furnished on order to suit the individual need.

PEERLESS PUMP DIVISION
FOOD MACHINERY AND CHEMICAL CORPORATION
Factories: Los Angeles, California, and Indianapolis, Indiana.
Offices: New York, Atlanta, Chicago, St. Louis, Phoenix, Fresno, Los Angeles; Dallas, Plainview and Lubbock, Texas.

ACCURACY

—another reason for Totco on your rig



What you're after is perfect angle indication... reading after reading with absolute accuracy.

Here's one of the many reasons for TOTCO accuracy—design of the angle indicator. Like a pendulum, TOTCO uses one point suspension. The indicator is balanced on a single fine point. There's little possibility of mechanical failure—no chance at all for repeated false readings.

Because of TOTCO's exclusive design the indicator comes to complete rest in less than ten seconds—perfectly poised for accurate readings. When the instrument records, the indicator point punches an easily read hole in the true-centered chart. The continuity of TOTCO readings is your accurate proof of drilling efficiency.

Be **SURE** *you know, use* **TOTCO**

AND YOU CAN TAKE TOTCO READINGS ANYTIME

Run in and out on measuring line.

Dropped down drill pipe; picked up with core barrel overshot.

Dropped down drill pipe; recovered when bit is changed.

Run in the Recorder connected to a core barrel overshot when picking up a retractable core barrel.

Run in and out on ordinary sand line.

You'll get *straighter holes* with a TOTCO Recorder and consistent readings to ⅛ of a degree... accurate, dependable drilling information worth big dollars to you in time and equipment savings. 23 field engineers plus the facilities of 71 Supply Stores are on call to help you drill faster, straighter holes. For accuracy, dependability, and complete service... call TOTCO.

TOTCO Recorder

Technical Oil Tool Corp., Ltd.

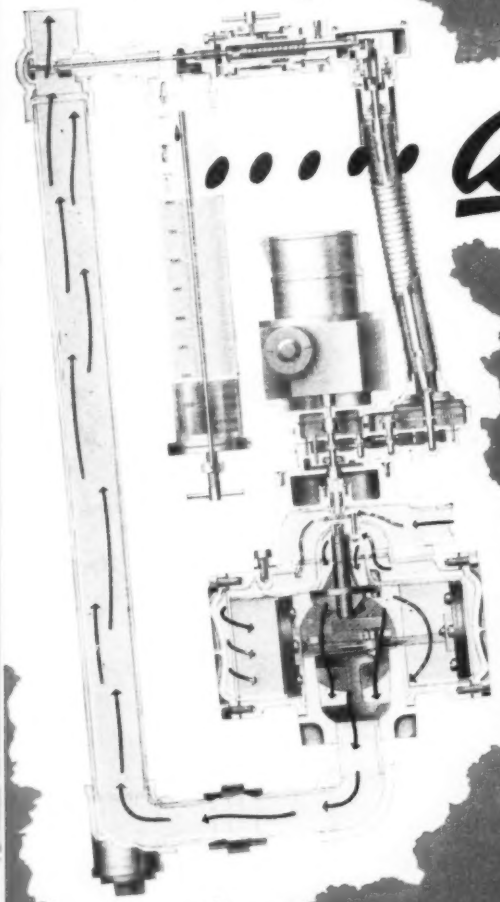
1057 N. La Brea Ave., Los Angeles 38, Calif.

Exclusive Distributors:

California—The Republic Supply Company of Calif.
Domestic—The Continental Supply Company
Canada—Oil Well Supply Company
Export—Lucey Export Corporation, New York City

How to Determine Oil-Water Ratio

. . . . at a Glance



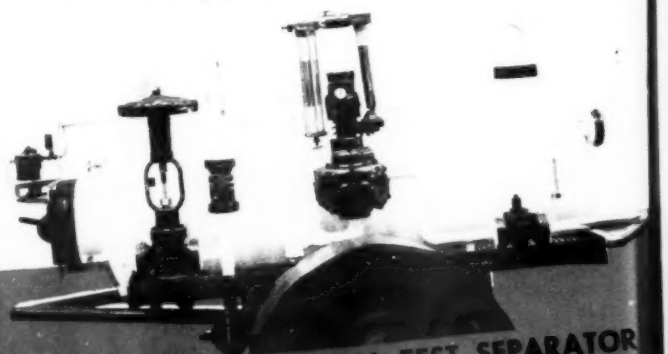
The sampler jar at fixed intervals gathers a few drops of fluid from the flowing stream. Thus a "cross-section" is collected of all the liquid measured by the meter over a given period of time. The gauger reads the oil-water ratio directly from a graduated scale. He then applies the proper correction factor to the meter reading to obtain the *true* volume of crude produced.

ROCKWELL *Oil field* METER and SAMPLER *gives you all these advantages*

- Eliminates expensive gauge tanks and piping
- Provides an accurate basis for royalties and taxes
- Produces accurate figures for field conservation studies
- Reduces fire hazard. Prevents wasteful evaporation losses
- Furnishes true proportionate well production ratios

Here's How It Works

This unit is installed in the line from the separator. The Rockwell piston meter accurately measures total output and also times the intervals when the sampler valve "grabs" a few drops of the metered liquid. Samples are taken from a rising stream—the only point where oil and water will mix to the same proportion as at the well head. The amount of each sample and the frequency can be field adjusted to suit conditions.



NATIONAL HORIZONTAL TEST SEPARATOR

This fully mobile well tester is fully automatic at minimum pressures. Equipment includes a Rockwell production meter with sampler, a Rockwell-Enco orifice meter and Nordstrom valves. It is produced by the National Tank Company, Tulsa, Okla., to whom inquiries should be addressed.

ROCKWELL MANUFACTURING COMPANY
Pittsburgh 8, Pa.

anta Boston Chicago Columbus Houston Kansas City Los Angeles
New York Pittsburgh San Francisco Seattle Tulsa

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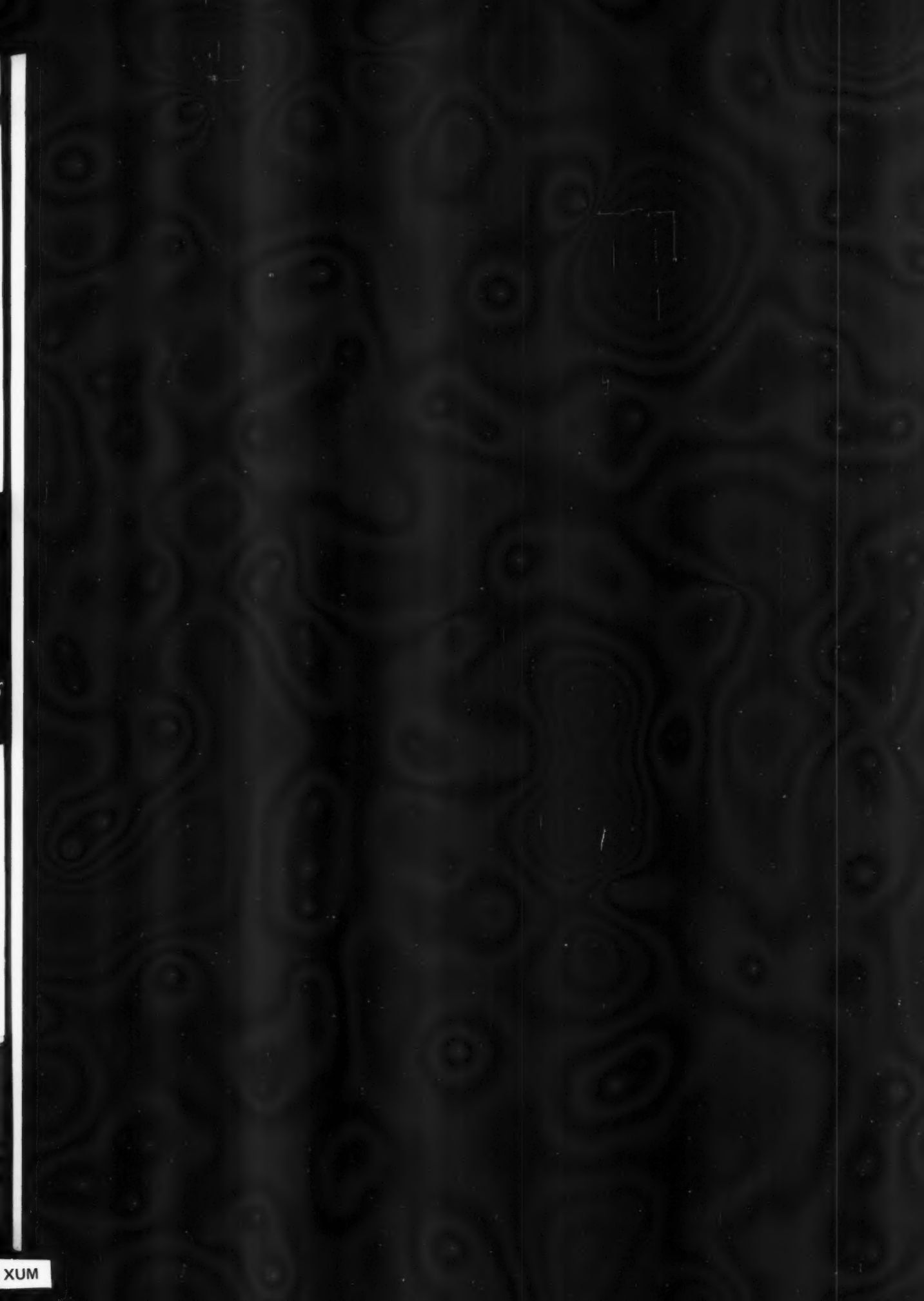
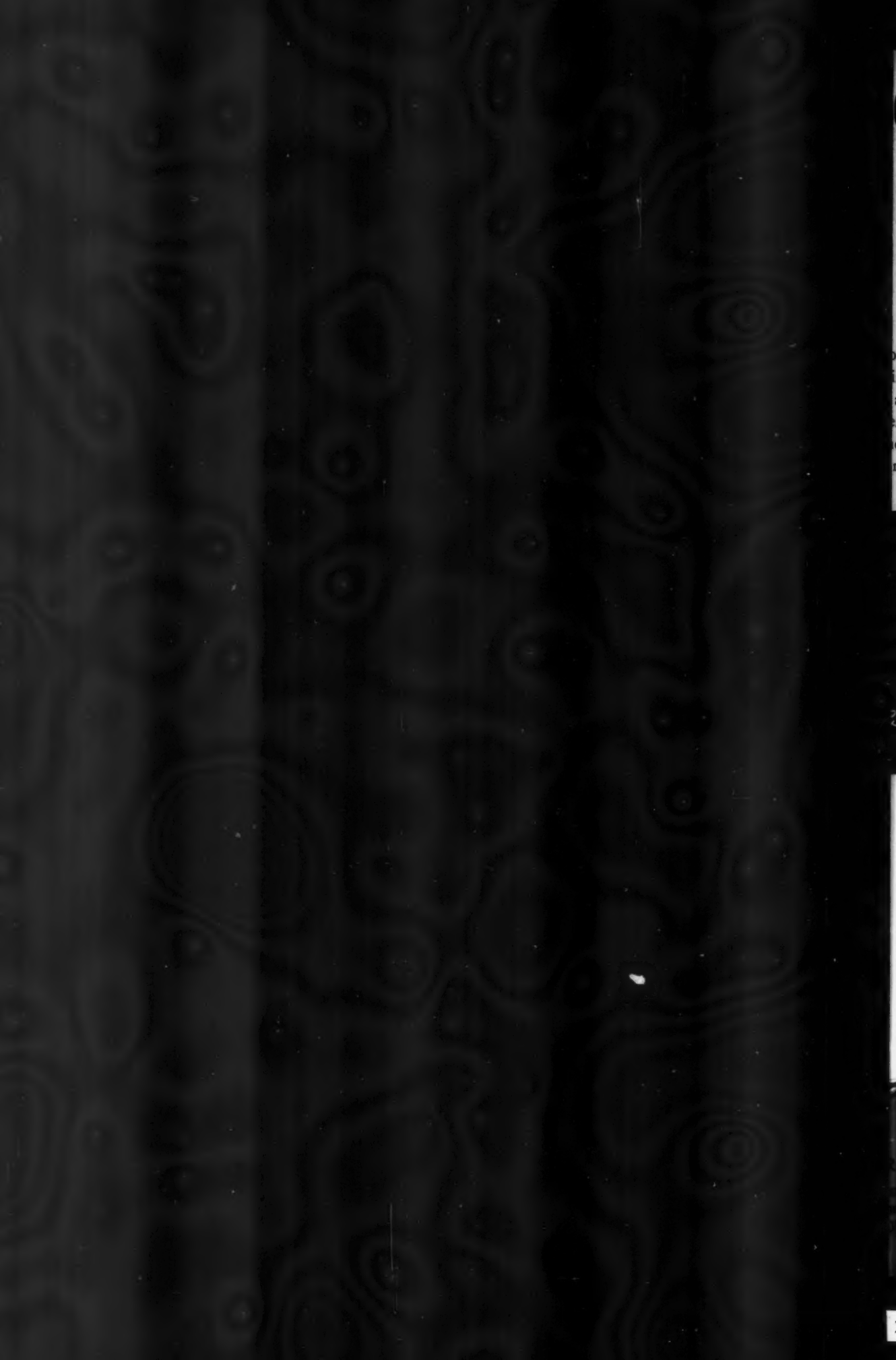




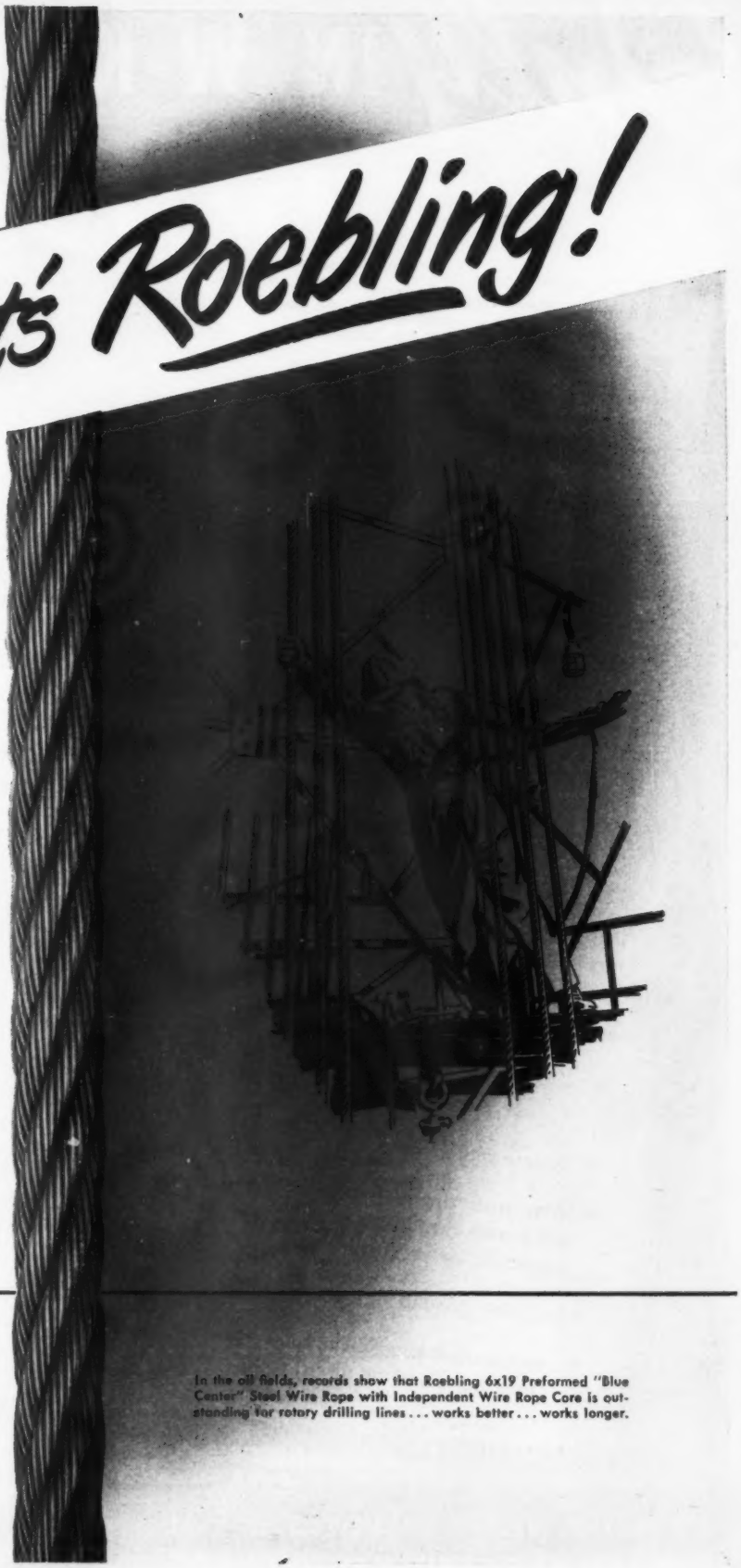
WORKS BETTER... WORKS LONGER... that's why

Today it's Roebling!

YOU GET THE MOST for your money with Roebling "Blue Center" Wire Rope. Roebling Preforming gives you the handiest, most efficient rope that you can put on the job. It's not inclined to kink or set, and that makes it quick and easy to handle and install. You can cut it without seizing. It spools better . . . has almost no tendency to whip and vibrate.

And besides the economies of superior performance, Roebling Preformed "Blue Center" Wire Rope saves money because it lasts longer. "Blue Center" steel—made only by Roebling—produces rope with superlative resistance to abrasion, shock and fatigue . . . Roebling craftsmanship and modern manufacturing facilities assure topmost uniform quality and value, always.

There's a Roebling wire rope for every sort of service and equipment. Have your Roebling Field Man help choose the *right* rope for dollar-savings in your operations. John A. Roebling's Sons Company, Trenton 2, New Jersey.



In the oil fields, records show that Roebling 6x19 Preformed "Blue Center" Steel Wire Rope with Independent Wire Rope Core is outstanding for rotary drilling lines . . . works better . . . works longer.

ROEBLING
A CENTURY OF CONFIDENCE

DISTRIBUTED BY:
THE NATIONAL SUPPLY CO.
REPUBLIC SUPPLY COMPANY

Only IN W-K-M VALVES

Seals in both open and closed position by parallel expansion directly across both seats . . . not by jamming or wedging into a tapered body and without any distortion whatever.

After reaching open or closed position, a slight movement of the handwheel expands this double tapered gate outwardly against the two over-size seats forming a perfect seal on both sides. Then, the first opposite movement of the wheel collapses the gate, away from the seats, sufficiently to allow the valve to be opened or closed without effort . . . against full rated pressure.

Chrome plated gates for resistance against corrosion add materially to the ease of operation of W-K-M Valves.

This is another of the several reasons why you may be sure that a W-K-M Valve will always effect a complete shut-off . . . will always open or close under full rated pressure.

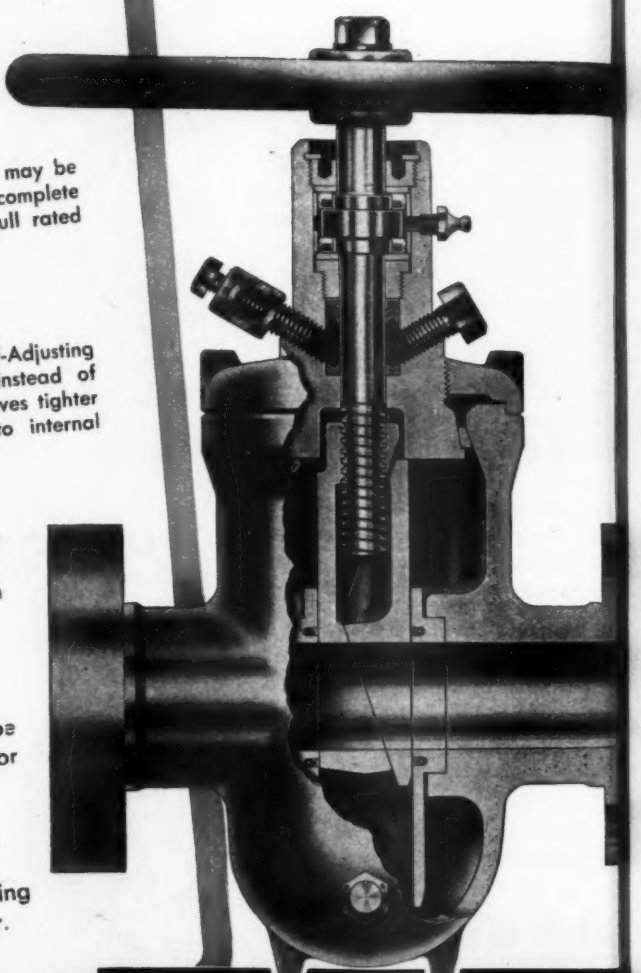
PRESSURE SEAL BONNET

Requires no flanges — no studs and nuts. Self-Adjusting to pressure and temperature changes . . . instead of tending to push bonnet off, greater pressure gives tighter seal . . . considerably less area exposed to internal pressure.

PLUS THESE OTHER PROVED FEATURES

- Double roller thrust bearings on stem for ease of operation.
- Chrome-plated gates.
- Stem and thrust bearings may be withdrawn through top of bonnet for inspection or replacement.
- Precision ground threads on stem.
- Combination plastic-chevron packing — uses no gland or gland follower.

THIS PARALLEL EXPANDING GATE SEALS DIRECTLY ACROSS BOTH SEATS



THIS IS THE NEW - IMPROVED W-K-M FLOW-LINE AND CHRISTMAS TREE VALVE

W-K-M Company

OIL FIELD, PIPE LINE & INDUSTRIAL EQUIPMENT

HOUSTON, TEXAS, U. S. A.
LOS ANGELES

Cable Address: "WILKOMAC"
Export Office: 30 Rockefeller Plaza, New York

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MARSH

... the gauge with the "Recalibrator"

Any pressure gauge can be knocked out of adjustment, but when it's a Marsh Gauge you can quickly correct it with the twist of the "Recalibrator" screw.

This is not only the handiest way to correct a gauge; it is also the best way. Conventional methods of adjustment simply compensate for the error. The "Recalibrator" corrects the relationship between the movement and the bourdon tube—actually *does re-calibrate* the gauge.

MARSH INSTRUMENT CO.
Sales affiliate of Jas. P. Marsh Corporation, Dept. L, Skokie, Ill.
Houston Plant, 1121 Rothwell St.

The Marsh line includes gauges especially designed for blenders, boilers, burners, capping, Christmas trees, columns, heaters, hydrogen units, instrument panels, pumps, Reid vapor bombs, scrubbers, separators, mud pumps, stills, towers and other applications including oxygen and welding gauges. Ask on your letterhead for new catalog just off the press.

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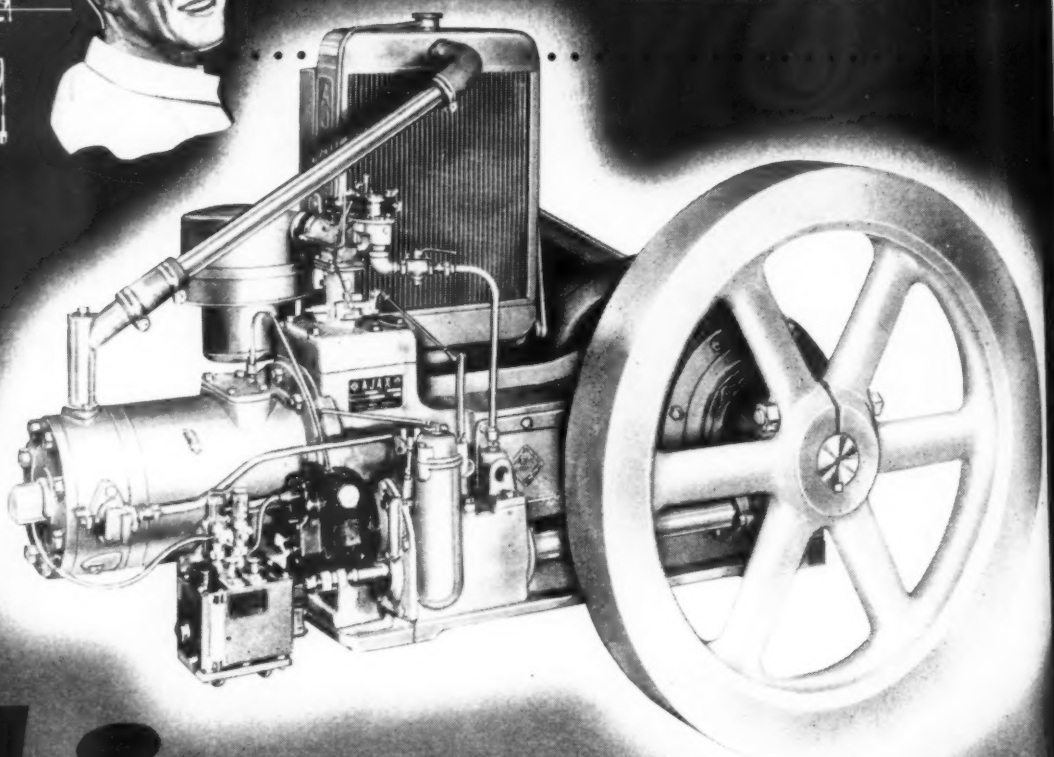
"YOUR *kind of engine*
for YOUR *kind of jobs!*"



Ajax GAS and OIL ENGINES

. . . designed and built

First and Foremost FOR OILFIELD SERVICE!

AJAX Engines are *natural-born* performers on oil country jobs because Ajax builds no other kind. Every specification, every material, every characteristic of our engines exist solely to serve the oil industry's requirements. — *Ask your supply man for the details!*

ENGINE BUILDERS for the Oil Industry Since 1877

AJAX IRON WORKS
CORRY, PENNSYLVANIA

Oil Field Distributors: THE NATIONAL SUPPLY CO., TOLEDO, OHIO
R. B. MOORE SUPPLY CO., INC., BOLIVAR, N. Y. · BETHLEHEM SUPPLY CO., TULSA, OKLA.

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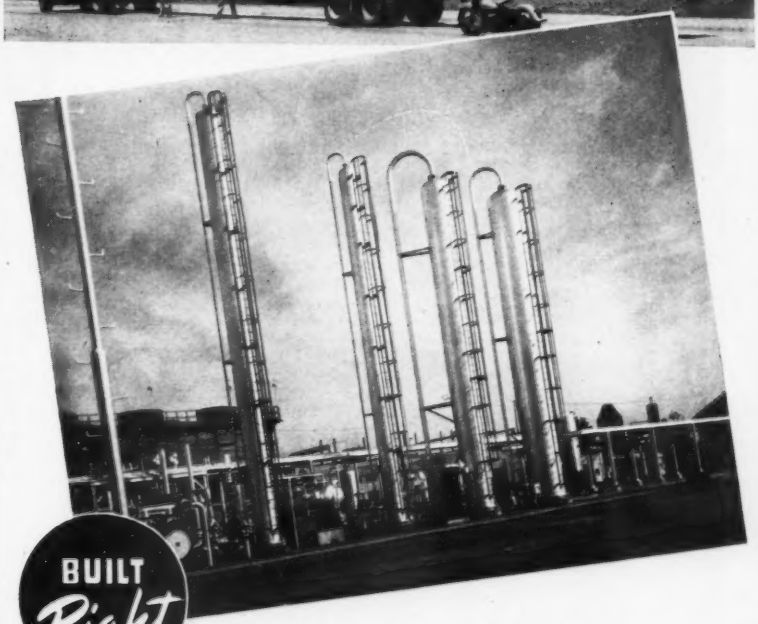
TULSA TYPE



BUILT *Right*

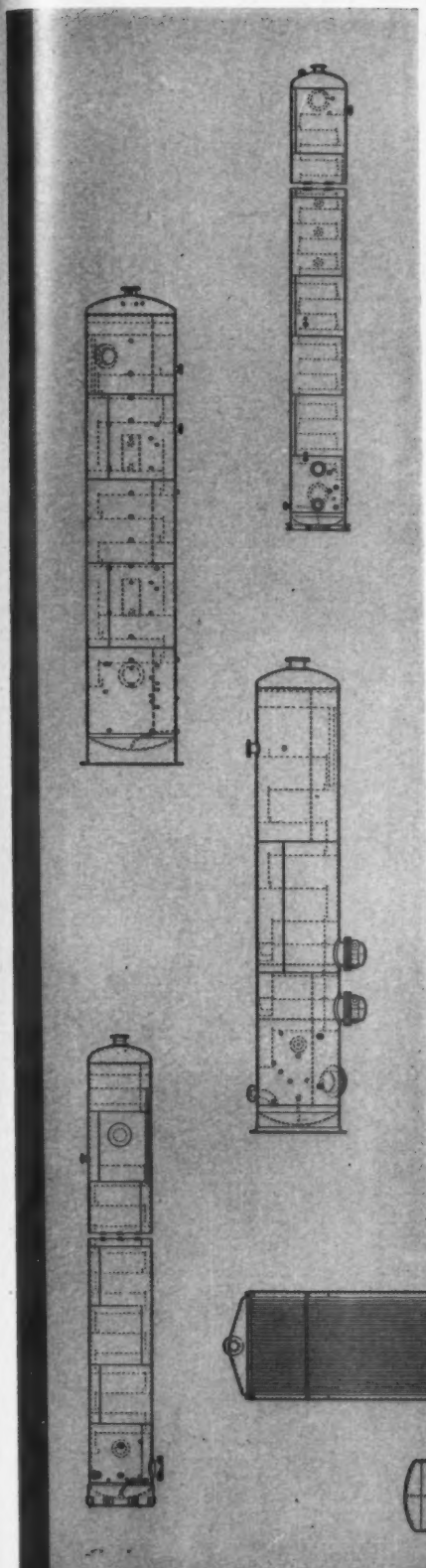
Close fractionation of hydrocarbons and high liquid output are operating features of TULSA TYPE Fractionating Columns.

TULSA TYPE is designed and fabricated to meet your specified operating conditions.

— Write for General Catalog —

FLINT STEEL CORPORATION

TULSA 1, OKLAHOMA



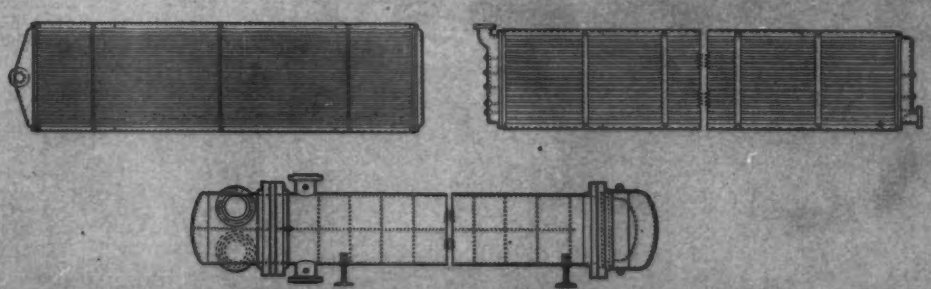
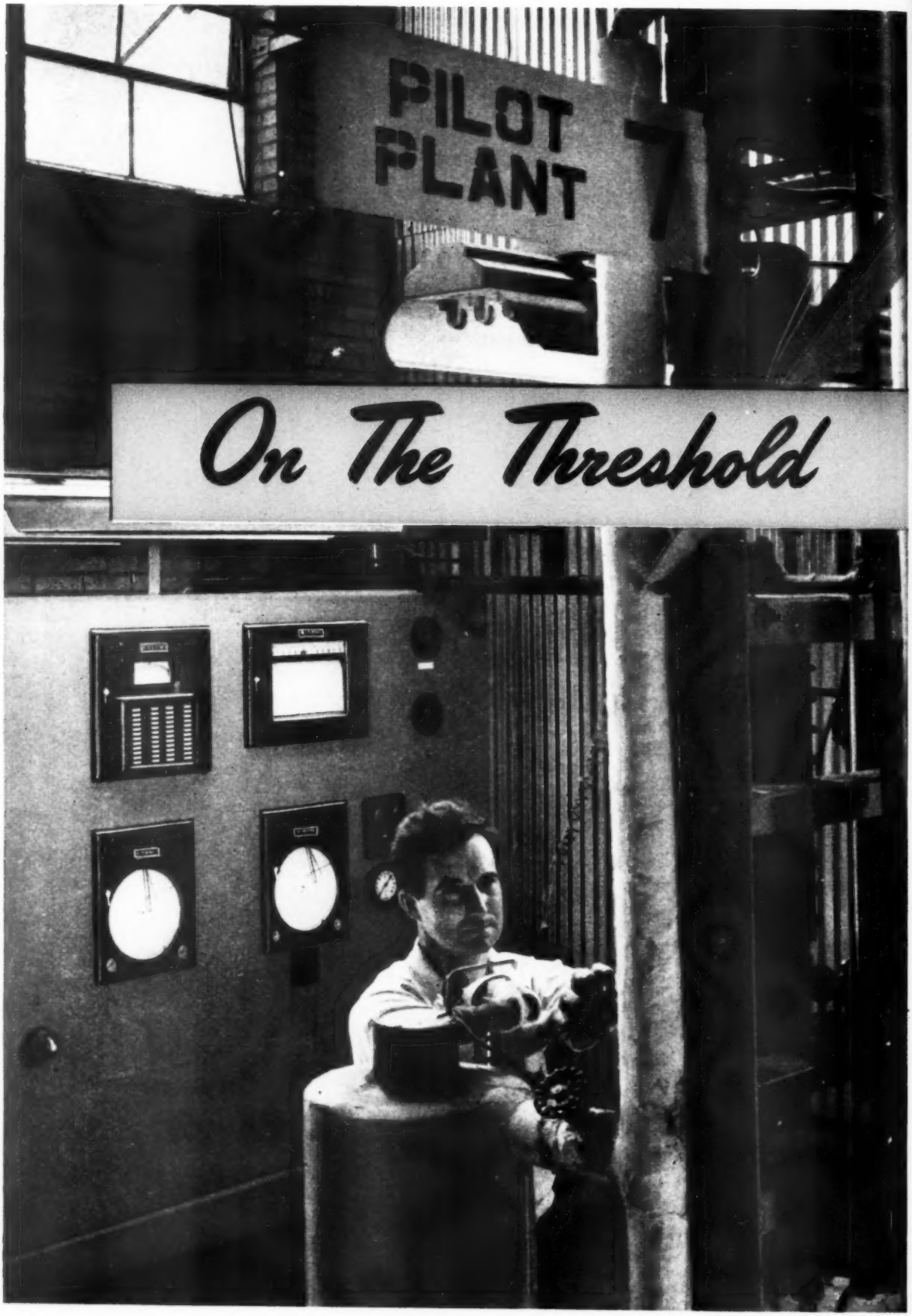


PLATE FABRICATING — STRUCTURAL FABRICATING

REINFORCING FABRICATING — WAREHOUSE PRODUCTS



On The Threshold

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# of Process Perfection

...WITH BROWN INSTRUMENTATION

MAINTAINING round-the-clock vigil over pilot plant operations is making increasingly greater contributions to perfection and profit in large-scale processing.

And Brown Instrumentation is playing a vital role.

The gap between fluid ounces in the laboratory and hundreds or even thousands of barrels per hour on stream requires the refinement of automatic control techniques to a new peak of perfection. Critical process temperatures, pressures, velocities, reflux ratios and pH values are some of the conditions which must be determined precisely in the pilot stages.

Unquestioned accuracy in measuring, recording and controlling of process variables enables the engineer to select the conditions best suited to the economical and flexible operation of a plant-size unit. Brown Instruments, offering practical flexibility and capacity for adaptation, appeal to the research and development directors who constantly are looking for greater sensitivity, precision and accuracy.

Perhaps *your* pilot plant operation can do a better job of setting *your* sights on *your* process possibilities with Brown Instrumentation. Call in your local Honeywell engineer for a detailed discussion of your requirements...he is as near as your phone! MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4488 Wayne Ave., Phila. 44, Pa. Offices in more than 80 principal cities of the United States, Canada and throughout the world.

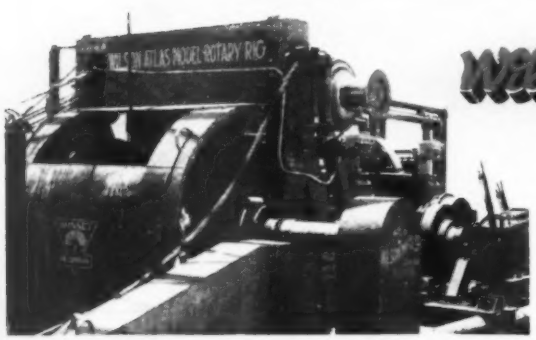
MINNEAPOLIS Honeywell

BROWN INSTRUMENTS

REMEMBER SIGNAL HILL

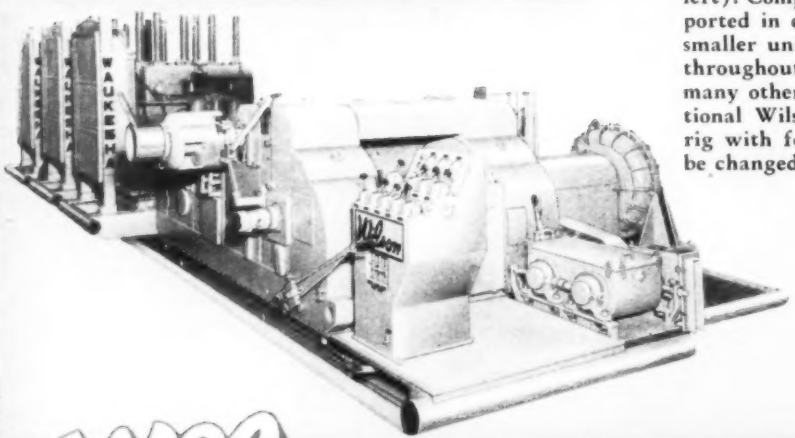
Did any of you old time derrickmen watch the fleet in the harbor?

Oranges, steam rigs, wooden derricks, earthquakes, bathing beauties, fires, and back yard wells were all combined with the California climate. Even yet it is still going strong. Long may it Flow!



Wilson *Was There!* **Wilson** *Was First!*

The first power rig on Signal Hill was a WILSON, June, 1937. The first power rig in California was a WILSON.



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The all new WILSON TORCAIR-ROADAIR RIG — th
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rig with four Air Clutch Speeds on the Drum that ca
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Write or call today for complete information on the New Wilson Torcair-Roadair Rig.

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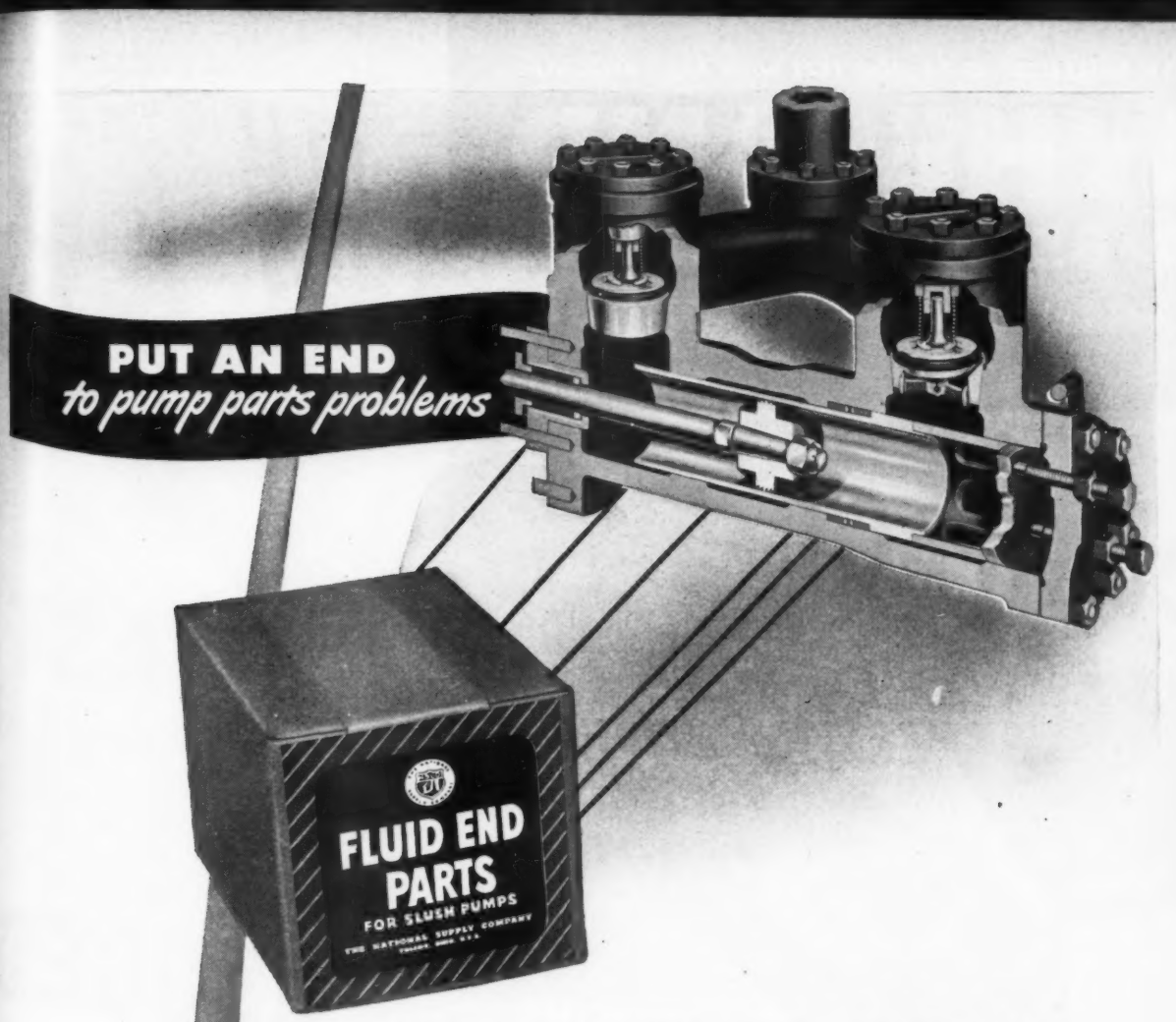

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Wheland rotary equipment to match the B-85 drawworks:

HP-14000 7½ x14 350 HP Slush Pump
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1. EASY—All controls grouped at driller's fingertips.
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3. FAST—Controls respond instantly to a touch of the finger.
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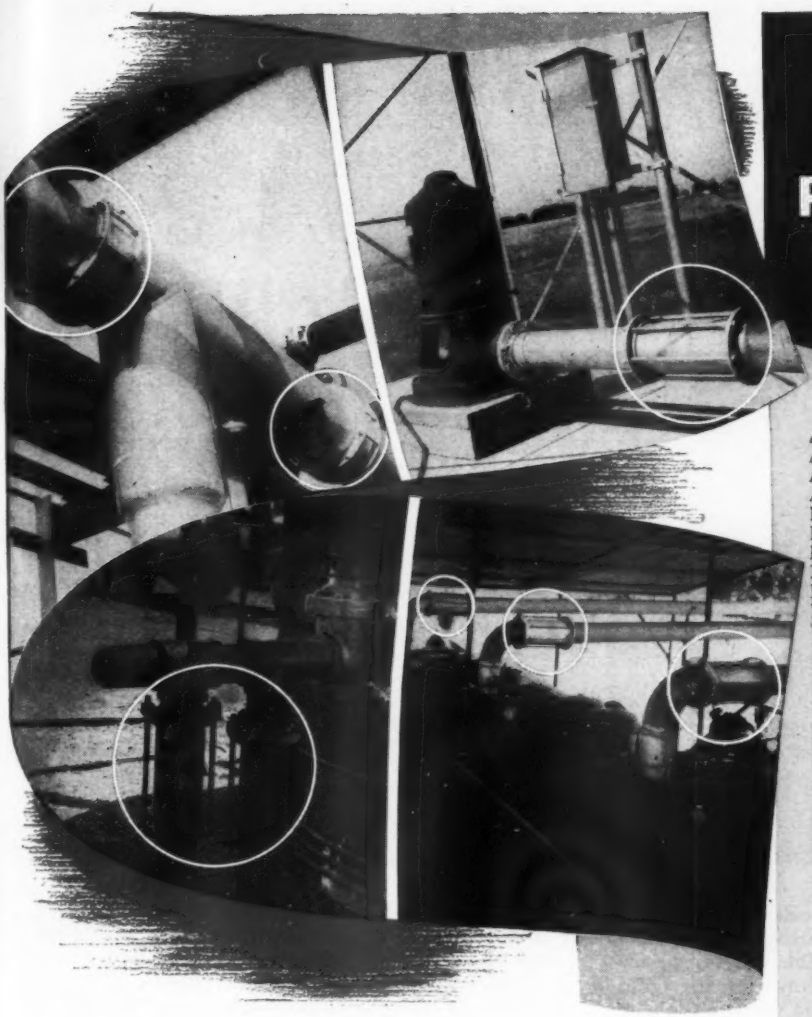

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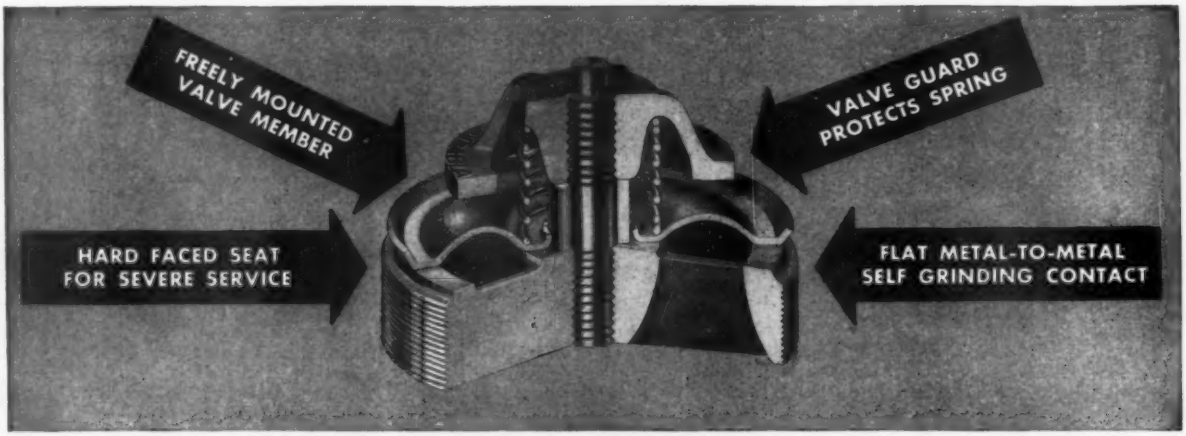
FREELY MOUNTED VALVE MEMBER
VALVE GUARD PROTECTS SPRING
HARD FACED SEAT FOR SEVERE SERVICE
FLAT METAL-TO-METAL SELF GRINDING CONTACT

1 **THEY ARE SELF-GRINDING:** Durabla Valve Units*, utilizing the freely mounted arched construction valve member exclusive to Durabla, are self-grinding, as the flat portion of the valve member is in direct contact with the flat valve seat and is free to move about its axis, thus producing a constant self-grinding action.

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3 **VALVE SPRINGS AND VALVE STEMS ARE PROTECTED:** The Valve Guard protects the Valve Spring from ever compressing more than 50% of its length. The Valve Stem is protected against breakage by the free mounting of the Valve Member.

Economy, efficiency and adaptability, based on long established service records and exclusive design make Durabla Valves your guarantee of reliable, uninterrupted pump operation.

You can specify Durabla Valves when you order a pump, (many manufacturers use them as standard equipment), or you can order Durabla Valves to fit any type of reciprocating pump, (they come with drive-fit seats or threaded seats with or without a shoulder to suit the job).

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*Patent Numbers 2090486, 2117504

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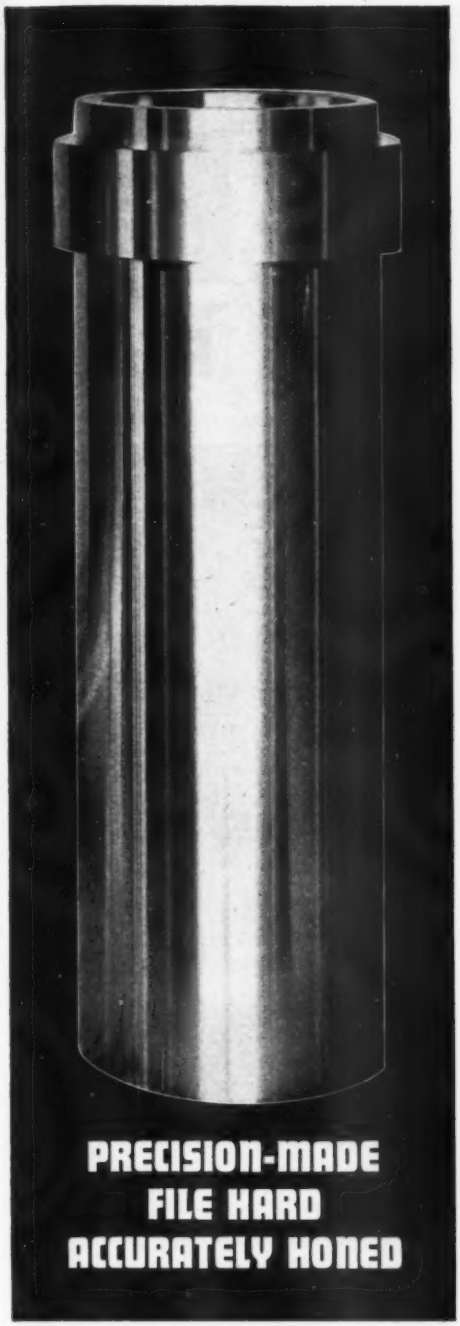

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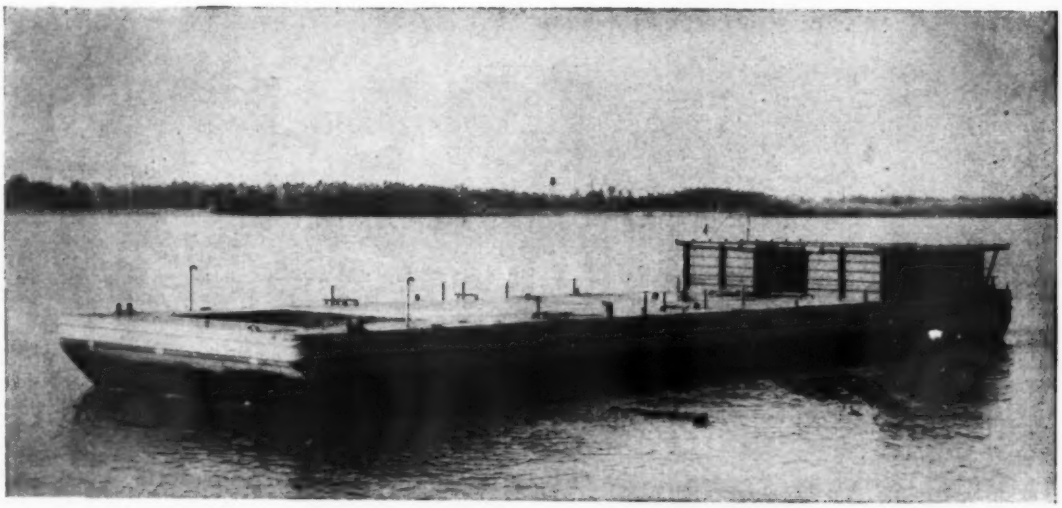
AVONDALE

BUILDS NEW DRILLING RIG



Built for Rowan Drilling Company, the huge barge is 200 feet long, 54 feet wide and 12 feet deep. It is a completely self-contained unit, with drilling equipment and power supply located on the same barge. The barge was launched exactly one month after the contract was signed and construction orders given. Frankly, such speed in this type of construction was possible because AVONDALE workers, skilled in steel, are thoroughly experienced in drill rig construction.

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QUICK REPAIR PLANT — HARVEY, LA.

This job's a pipe with TIMKEN® bearings

"LAYING IN" a 34-inch high pressure gas line across the California desert is a tough job. To put such a pipeline to rest takes plenty of engine power and stamina, means extra hard work for transmission gear shafts.

With the bevel gear shafts, sprocket shafts and idler pinions of these "Caterpillar" D8 Tractors mounted on Timken® roller bearings, long trouble-free operation is assured—these machines stay on the toughest jobs with a minimum of maintenance.

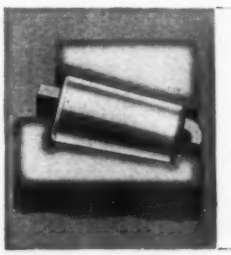
Timken bearings hold moving parts in rigid alignment, prevent excessive wear and insure smooth operation. They permit use of tight, lubricant-retaining closures that keep out damaging dirt and moisture. In spite of rough going, lubrication and maintenance are held to a minimum. Equipment lasts longer, works better.

Timken bearings are made of the finest steel ever developed for tapered roller bearings—Timken alloy steel. Rollers and races are case-hardened to provide a hard, wear resistant surface and tough, shock-resisting inner cores. Line contact between the rollers and races give extra load-carrying capacity. Even under the heaviest loads, true rolling motion and smooth surface finish enable Timken bearings to operate freely, frictionlessly. They can take any combination of radial and thrust loads, and normally last the life of the machine.

No other bearings can give your equipment *all* the advantages you get with Timken bearings. They're backed by 50 years of bearing research and development. Be certain there are Timken bearings in the equipment you build or buy. Look for the trade-mark "Timken" on every bearing. The Timken Roller Bearing Company, Canton 6, O. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.

These **"CATERPILLAR"** *Diesel Tractors equipped with side booms, use Timken tapered roller bearings on the bevel gear shaft, sprocket shaft and idler pinion to insure longer life and less maintenance.*



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Because the load is carried on the *line* of contact between rollers and races, Timken bearings carry greater loads, hold shafts in line, wear longer.

The Timken Roller Bearing Company is the acknowledged leader in: 1. advanced design; 2. precision manufacturing; 3. rigid quality control; 4. special analysis steels.

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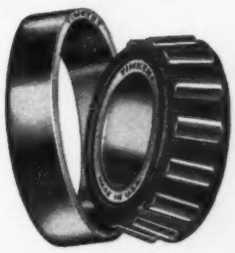
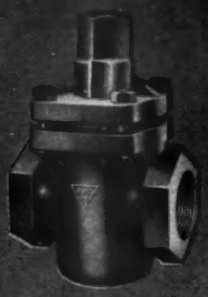
TAPERED ROLLER BEARINGS



NOT JUST A BALL ◯ NOT JUST A ROLLER ⬭ THE TIMKEN TAPERED ROLLER ⬭ BEARING TAKES RADIAL ◫ AND THRUST →◫← LOADS OR ANY COMBINATION ✳

more and better service from

R·P&C VALVES



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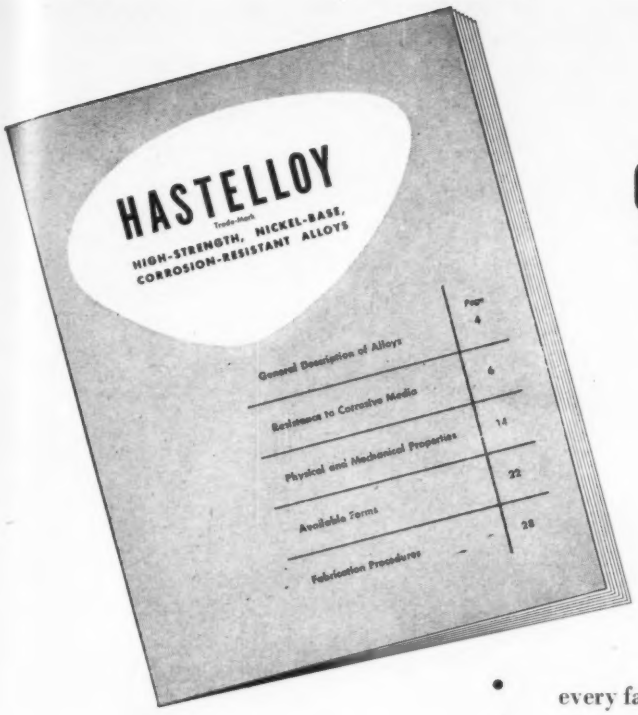

Get the latest data on 4 ALLOYS to combat severe corrosion

Every designer . . . every engineer . . . and every fabricator who is faced with the problem of selecting a high-strength material that will withstand severe chemical corrosion should have a copy of this new 40-page booklet. It tells the story of the four HASTELLOY alloys—what they are, how they are fabricated, and how they can be used to combat severe corrosion.

HASTELLOY alloys are being used successfully in every branch of the chemical and allied industries . . . in the production of chemicals, petroleum, textiles, plastics, aircraft, and metals. To get the latest data on these versatile materials of construction, just fill out the handy coupon below for your free copy of the booklet, "HASTELLOY High-Strength, Nickel-Base, Corrosion-Resistant Alloys."

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Description of the HASTELLOY Alloys—A brief summary of the chemical composition and physical properties of the four alloys: A, B, C, and D.

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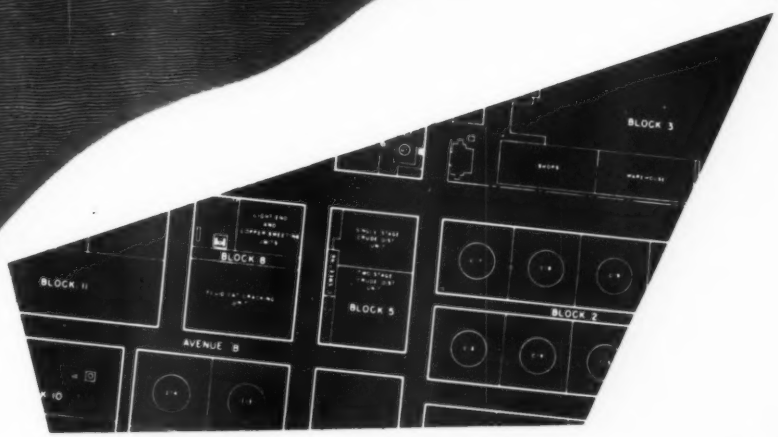
refiners dream, too . .



. . . of an ideal refinery layout . . . of a low-cost catalytic cracking unit . . . of new processes to keep pace with the ever-increasing Octane requirements . . . of a new crude unit, etc., . . . etc., . . . etc. . . .

Working with refiners throughout the world, for over 30 years, converting such ideal images—over 500 of them—into physical reality has been the job of the complete engineering and construction service—FOSTER WHEELER.

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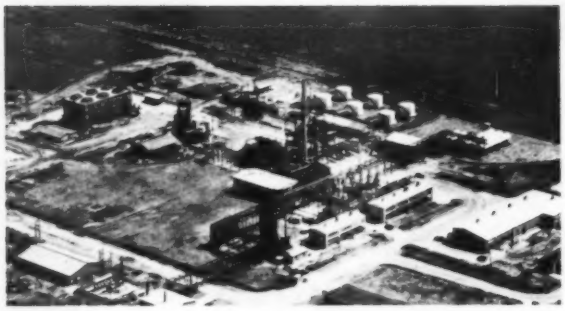
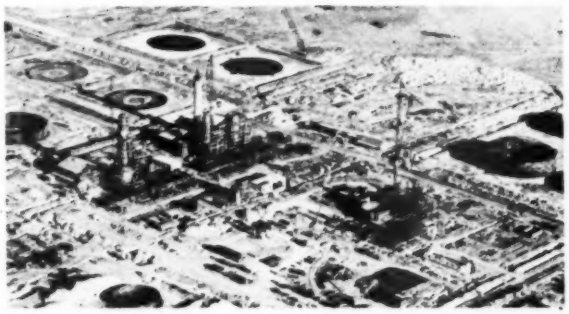
ONCE... these were but dreams



NOW . . . in Texas, a complete chemical plant is operating.

NOW... in Spain, a complete lube refinery is producing superior lubricants.



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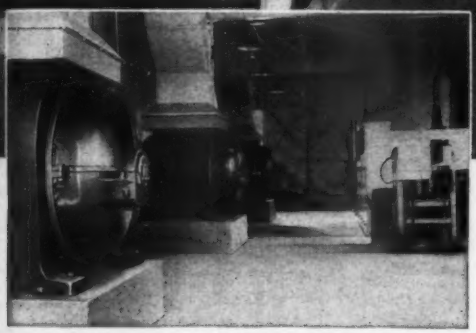
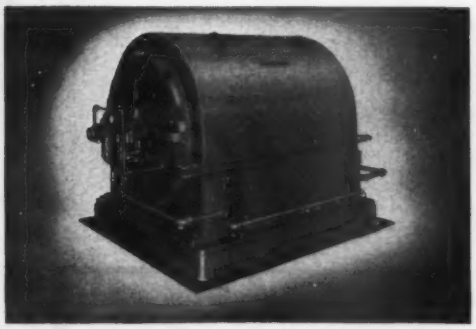
MOTORS TO MATCH YOUR PIPELINE NEEDS

No firewall is needed between pumps and motors when you use G-E explosion-proof motors, as with these two 400-hp motors direct coupled to main pumps in a Pennsylvania pipeline station.



Where a firewall is called for by station design, choose G-E squirrel-cage open induction motors for low-cost reliability. Here, three 1500-hp motors of this type, with top air-discharge enclosures, drive the pumps through a firewall in a Southern pipeline station.



No firewall is used with this 1500 hp G-E externally forced base-ventilated motor, one of several now being installed in a large Southwestern crude line. A separate motor-driven blower purges the motor and duct system of hazardous gases. Air ducts are located below the floor level.

Broad range of G-E motors makes correct selection easier

When you make General Electric your single supply source for all your electrified pipeline needs, you're sure of the widest variety of motor types and sizes to choose from:

Motors that meet any area condition—low-cost open motors to operate behind a firewall, or enclosed motors designed for use in hazardous areas which require no firewall.

Motors for centrifugal or reciprocating pumps—squirrel-cage induction motors of relative simplicity and low cost for centrifugal pumps, or synchronous motors with high operating efficiency and ability to improve load power factor for reciprocating pumps.

Motors for constant or adjustable speed—constant-speed motors direct-coupled to centrifugal pumps for lowest installed cost, or wound-rotor induction motors to supply adjustable speed for more efficient operation at reduced flow.

All these G-E motors offer the advantages of fast and easy installation, minimum maintenance, and long-lasting dependability. Selected with the aid of G-E application engineers who know pipeline industry needs, they're a good bet to help cut your pumping costs. For the full story, call your nearest G-E office. *Apparatus Dept., General Electric, Schenectady 5, N. Y.*

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to cut oil pipeline costs
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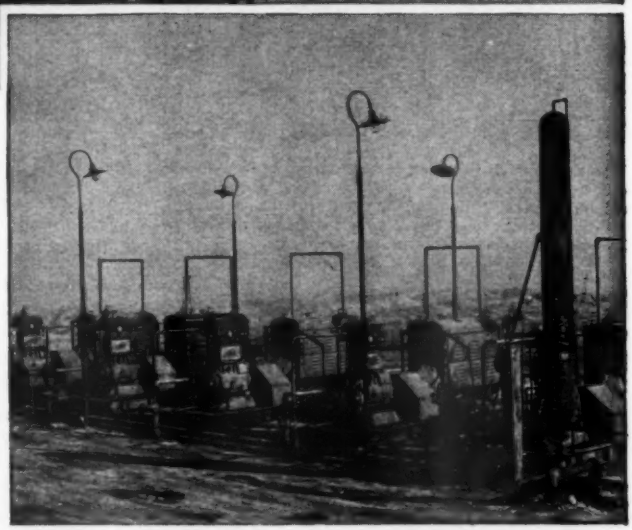

The surest way to maintain steady high-level production is through dependable uninterrupted power. Minneapolis-Moline engines for oil field power have built an enviable record for continuous duty without mechanical shutdowns.

Low cost installations of MM heavy-duty engines that provide 25 to 230 h. p. offer exceptional maintenance economy and long engine life. In addition you get these MM exclusive features: *crankcase ventilation, heat exchanger base pans, high-turbulence combustion chambers, regulated cooling, by-pass thermostats, removable cylinder heads and blocks, extra large bearing surfaces, replaceable bearing shells that are steel-backed and precision made, water-cooled manifolds,* and many others.

You, too, will agree that Minneapolis-Moline engines are quality constructed and skillfully engineered for heavy-duty performance in oil field operations.

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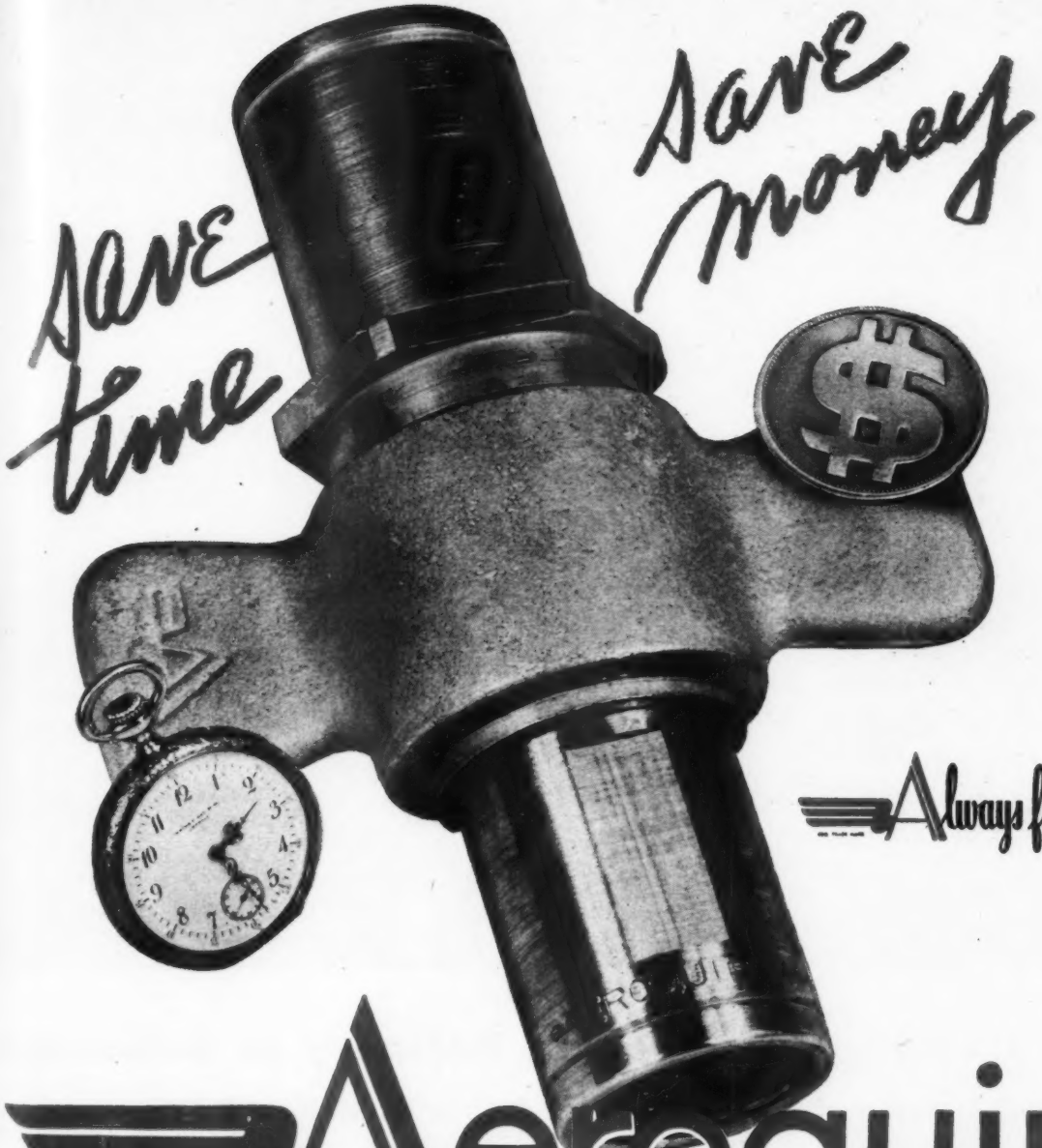

Aeroquip

REG TRADE MARK

SELF-SEALING COUPLINGS

Aeroquip provides the fastest, most economical method known for disconnecting and reconnecting charged, fluid-carrying lines. One coupling takes the place of two hand-operated valves. It reduces downtime for service and maintenance and permits speedy interchangeability of accessories. Used with water, hydraulic fluid, oil, diesel fuel, gasoline and refrigerant gas lines.

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JACKSON, MICHIGAN

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AEROQUIP PRODUCTS ARE FULLY PROTECTED BY PATENTS IN U. S. A. AND ABROAD

XUM

New 30,000 Barrel Pemex Refinery at Salamanca

Engineered and Constructed by Arthur G. McKee & Company

LOCATED in an important industrial and agricultural area of the high plateau region of Mexico, this refinery is one of the most beautiful ever built. Sound, thorough engineering is clearly evident in its well-planned, clean-lined arrangement and efficient construction.

The complete refinery is comprised of processing units for Crude Distillation, Thermal Cracking and Catalytic Desulfurization and units for gasoline and kerosene treating and ethyl blending. Power plant, steam plant, water supply system, tankage and extensive shop and maintenance facilities are provided.

With a 30,000-barrel-per-day capacity, this new refinery is designed to produce gasoline, kerosene, diesel oil, other gas oils, liquefied petroleum gas and residual fuel oil.

ARTHUR G. McKEE & COMPANY

DESIGN, ENGINEERING AND CONSTRUCTION FOR THE PETROLEUM REFINING AND IRON AND STEEL INDUSTR

ENGINEERS AND CONTRACTORS • ESTABLISHED 1905
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XUM

Built to Cut Maintenance

EASIER MAINTENANCE PROCEDURES and lower maintenance costs are important features of this brand new line of large motors. One man can perform all routine maintenance procedures, including opening up the motor for cleaning. Bearing surfaces are not exposed to abrasive grit and dirt during cleaning operations.

The appearance of this new line of large motors reflects the advanced design and fine workmanship that goes into their manufacture.

A well-braced, sturdy fabricated steel frame with cast-iron end brackets rigidly support and protect working parts. Ventilating openings are large to provide adequate cooling air at low velocities with resultant low sound level.

Wide Range of Sizes

These new design Allis-Chalmers drip-proof and splash-proof squirrel-cage induction motors are built in sizes from 60 hp at 300 rpm to 1500 hp at 1800 rpm. Ask your Allis-Chalmers representative to show you the details of this exceptional new motor or write for Bulletin 05B6112.

How's This for Accessibility

One man can remove the end brackets and air baffles and reach right inside motor with his vacuum cleaner or air hose. Bearing remains sealed against abrasive dirt throughout the cleaning operation.

Large air discharge openings with removable louvers allow plenty of room to get in with an electric drill for doweling and bolting the motor to the base. Plenty of room to reach up back of the stator core for cleaning.

A-3179

ALLIS-CHALMERS, 1059A SO. 70 ST.
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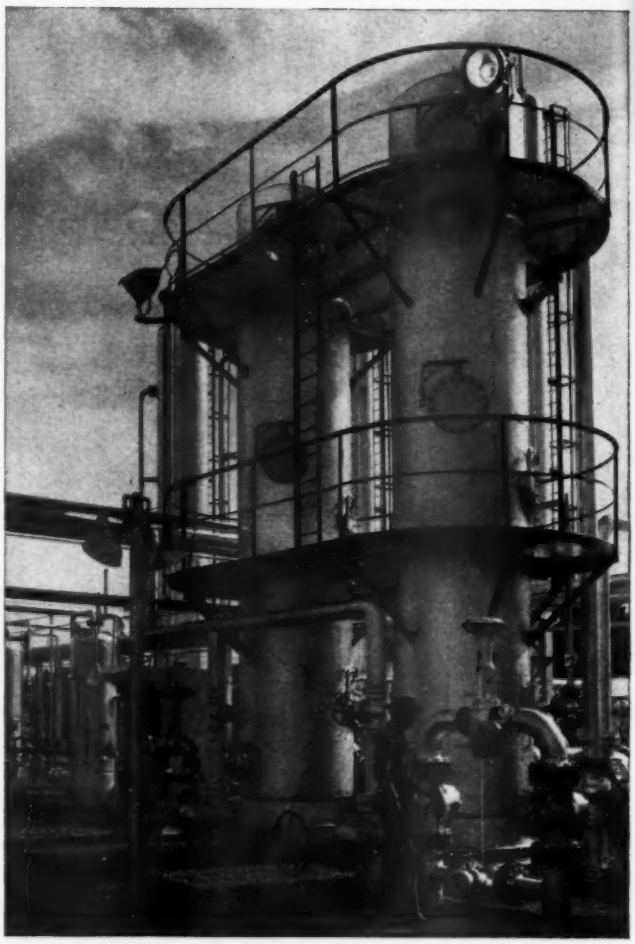
ALLIS-CHALMERS

XUM

AMERICAN REPUBLICS CORPORATION DRIES RESIDUE GAS TO MINUS 10° F. with ALCOA Activated Alumina

American Republics Corporation depends on ALCOA Activated* Alumina to dry residue gas at their Silsbee, Texas, gasoline plant.

Each of the two dehydrating towers, illustrated, is charged with 16,000 lbs. of ALCOA Activated Alumina. Gas, entering the towers at approximately 100° F. and 900 psig, is dried to dew points not exceeding *minus* 10° F. Approximately 15,000,000 standard cubic feet of gas passes through the towers daily. Reactivation is accomplished with natural gas heated to 375° F.



ALCOA Activated Alumina was chosen for this installation because it is *dependable* and *economical*. It can be reactivated an almost unlimited number of times, without appreciable effect on its moisture adsorption efficiency.

ALCOA Activated Alumina will readily and repeatedly adsorb moisture from vapors and gases to dew points below *minus* 100° F. without changing its form or properties. It does not soften, swell, or disintegrate even when immersed in water. Furthermore ALCOA Activated Alumina is chemically inert to most gases and liquids, and is non-toxic.

ALCOA Activated Alumina is an efficient, long-lasting desiccant for dehydrating to dew points even below *minus* 100° F. Let us send you complete information. ALUMINUM COMPANY OF AMERICA, CHEMICALS DIVISION, 618L Gulf Building, Pittsburgh 19, Pennsylvania.

*Reg. T. M., Aluminum Company of America

Alcoa Chemicals

ALCOA

ALUMINAS and FLUORIDES

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Typical API flat belt pumping unit with counter shaft hook-up.

End High Belt Costs with . . .
MANHATTAN API COMPENSATED BELTS

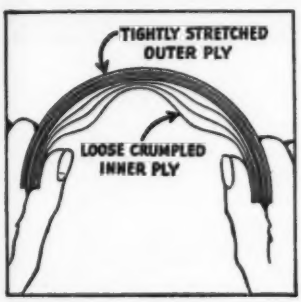

Illustration A

The cause of most belt failure is outer-ply rupture and failure at the fastener. This is due to the uneven stresses between plies of the ordinary belt when rounding a pulley. You can see how these stresses occur by bending a pack of paper (Illustration A). The inner plies loaf and the outer plies become over-loaded, causing them to fail prematurely.

. . . Not so with Manhattan API Belts!

Manhattan belting engineers have found a way to *equalize* the stresses between plies so that every ply pulls an equal share of the belt load when rounding the pulley. This enables Manhattan API *Compensated* Belts to outlast other belts as much as three to four times.

Among twelve proved advantages of the Compensated construction are elimination of outside ply rupture and longer fastener life, freedom from ply separation and less wear on the driving surface. You also have a greater overload capacity, greater margin of safety, and consequently longer service.

By investing in the longer life that is built into Manhattan API Compensated Belts, you definitely lower your well pumping Costs. Check today with your nearest National Supply Company representative.

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MANHATTAN RUBBER DIVISION — PASSAIC, NEW JERSEY

RAYBESTOS-MANHATTAN, INC.

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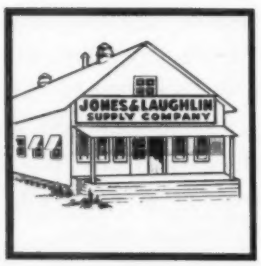
ONE-STOP
Supply Service for



Now—more than ever—waste should be eliminated.

In all branches of the oil industry there is a growing tendency to buy more efficiently. Wherever there is a Jones & Laughlin Supply store you'll find One-Stop Supply Service. This saves time and bookkeeping.

Equipment purchased through this One-Stop Supply system is the best the market affords. All items are known to be "sterling"—never a substitute.

Put your operations on a more efficient basis. Look to your nearby Jones & Laughlin Supply store. Begin the elimination of wasteful buying methods by using this 80-Store One-Stop Supply Service.

Member Petroleum Equipment Suppliers Association

XUM

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also
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8 Resident Salesmen

"... here's MY warehouse!"

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PIPE LINE CLAMP

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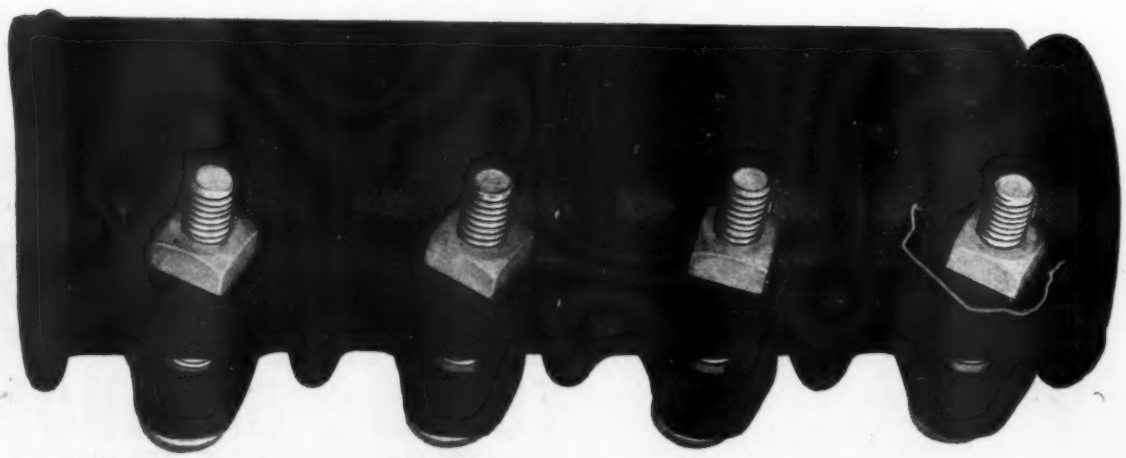

TOPS IN . . .
REFINERY EQUIPMENT

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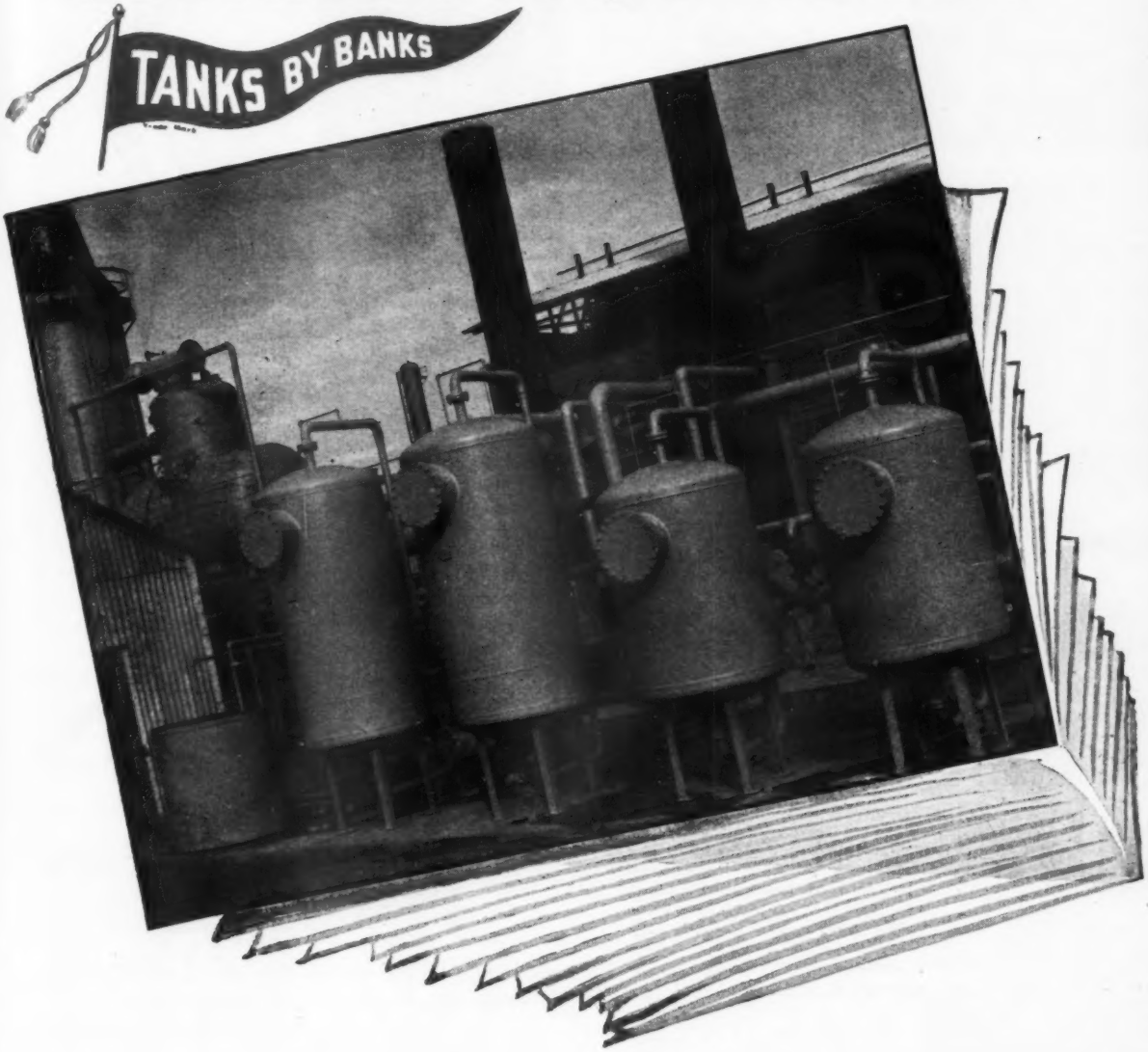

TANKS BY BANKS means refinery equipment of top quality from drafting board to completed fabrication.

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Select Your Steel Valves

Edward GAGE VALVES 600 lb sp

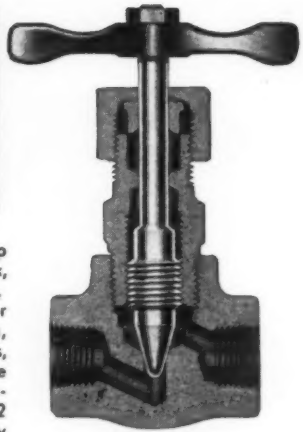


Fig. 152

FIG. 152 SERIES—A drop forged, instead of bar stock, steel valve for gage, meter, dead-end, instrument and other small lines, and for pumps, vents, Diesel and gas engines, etc. Long taper semi-needle type stem-disk for close regulation and tight seating. Fig. 152 series has carbon steel body with EValloy 13% chrome stem-disk. Fig. 2152 series, all 13% chromium stainless steel. Fig. 4152 series, all 18-8 stainless steel.

Screwed Ends—Globe or Angle

Size Range—⅛", ¼", ⅜", ½", ¾" and 1"

Edward Globe & Angle Valves 600-1500 lb sp

Fig. 444-944

FIG. 444-944 SERIES—All purpose valves, ideal for nearly any service where O. S. & Y. small forged steel valves are used. Streamlined, low-pressure loss body and bonnet both forged steel. Built with union bonnet in sizes 1" and smaller for 600 lb sp, and in sizes ¾" and smaller for 1500 lb sp. Larger sizes in both pressure classes have bolted bonnet joint. Bronze bushed yoke, simplified bolted gland design for easy packing adjustment, EValpak high pressure-high temperature die-molded packing, and inclined stem design for free flow and minimized turbulence are standard features. Easy to repack, with both hands free to insert packing. Stem, disk and seat hardened EValloy 13% chromium stainless steel regularly furnished; Stellite hard-faced seat and disk available on order.

Fig. 448-948

Screwed or Socket Welding Ends—O. S. & Y —Globe or Angle

Size Range—¼", ⅜", ½", ¾", 1", 1¼", 1½" and 2"

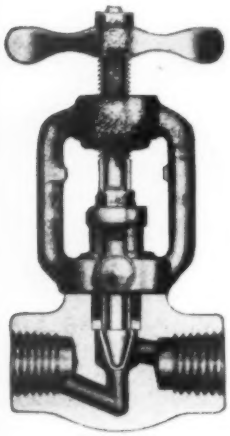


Fig. 952

Edward INSTRUMENT VALVES 1500 lb sp

FIG. 952 SERIES—A compact, heavy-duty valve for instrument panels, regulators, orifice meters, by-pass lines, oil field gage or instrument services, corrosive lines, etc. Drop forged steel body and yoke. No possibility of bonnet joint leakage. Swing bolted gland. Fig. 952 series valves have carbon steel body with EValloy 13% chromium stainless steel trim. Fig. 2952 series has EValloy stainless steel body and trim.

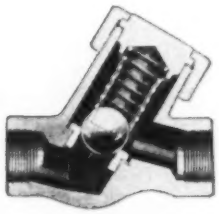
Screwed or Socket Welding Ends—O. S. & Y.—Globe or Angle

Size Range—¼", ⅜", ½"

Edward CHECK VALVES 600-1500 lb sp

WIDE CHOICE

Edward forged steel check valves are built in ball or piston types, with union or bolted bonnets, with screwed, socket welding or flanged ends. Available for installation in either horizontal or vertical lines.

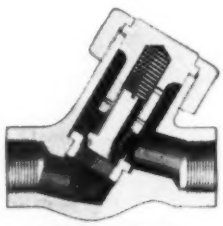


BALL CHECKS

Ideal for viscous fluid service. Spring loaded. fully guided ball disk is stainless steel, as is the mated seat.

Screwed or Socket Welding Ends—Horizontal or Vertical.

Size Range—¼", ⅜", ½", ¾", 1", 1¼", 1½" and 2".

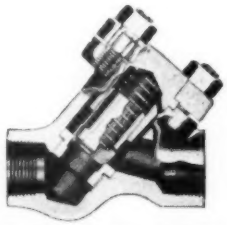


PISTON CHECKS

General service small check valves that give freedom from shock or excessive vibration, yet seat quickly and tightly upon flow reversal.

Screwed, Socket Welding or Flanged Ends—Horizontal or Vertical.

Size Range—¼", ⅜", ½", ¾", 1", 1¼", 1½" and 2".



BOLTED COVER CHECKS

Either ball or piston types, in variations of body style and end connections for boiler feedline or general process services.

Screwed, Socket Welding or Flanged Ends—Horizontal, Vertical or Angle.

Size Range—½", ¾", 1", 1¼", 1½" and 2".

XUM

From New Edward Designs

These are among the many new Edward designs. The Edward steel valve line is never static. From a development department devoting its time exclusively to the problems of temperature, pressure and other operating conditions usually associated with the use of steel valves, have come—through the years—literally hundreds of design and material innovations. Many Edward features have become industry standards; others are still exclusive with Edward. The new designs described briefly here are ideally suited for the service conditions of today's power plant, petroleum, industrial and technological installations.

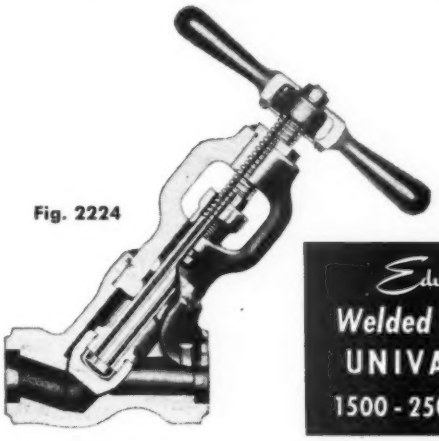


Fig. 2224

Edward
Welded Bonnet UNIVALVES
1500 - 2500 lb sp

FIG. 2224 SERIES—Welded bonnet, inclined stem forged steel globe valves. Integral Stellited seat and disk construction, perfect alignment between body and bonnet, contoured for least resistance to flow and to cut wear-producing erosion. Bonnet joint leakage forever eliminated. Forged chromium-molybdenum bodies. Impactor handle available on larger sizes. Fig. 2224 series for 1500 lb service; Fig. 3924 for 2500 lb sp.

Socket Welding Ends—Globe Type

Size Range—½", ¾", 1¼", 1½" and 2"

Edward
BLOW-OFF VALVES
300-600
1500 lb sp

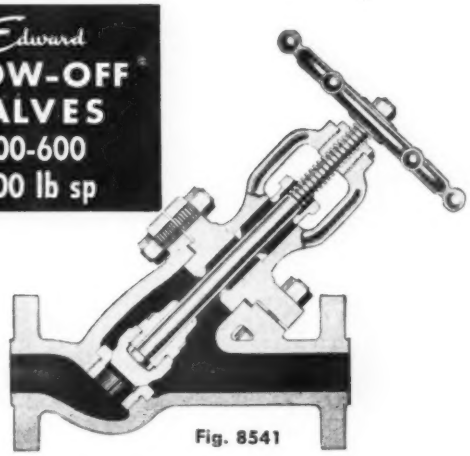
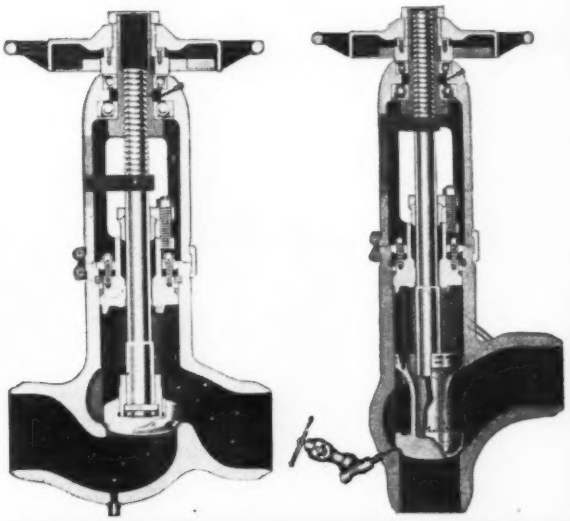


Fig. 8541

FULL RANGE—Edward cast and forged steel blow-off valves, in straightway or angle patterns, meet all standards for blow-off valve service, and give complete flexibility in working piping hook-ups for any space limitation. Slow-opening type so that damaging shock to piping is eliminated.

Flanged or Socket Welding Ends — Straightway or Angle

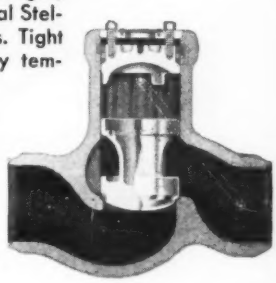
Size Range—1½", 2" and 2½".



Cast Steel Pressure-Seal Valves

900-1500-2500 lb sp

GLOBE AND ANGLE STOP, NON-RETURNS, CHECKS—Newest design pressure-seal bonnet valves in globe or angle stop or non-return and horizontal or angle check valves. Many features are Edward "firsts"—Impactor handwheels, EValthrust yoke bushings, Equalizers, streamlined flow passages, etc. Regularly built with integral Stellited seats and Stellited disks. Tight bonnet-joint connection at any temperature, low maintenance, easy disassembly, proven materials for top temperatures and reduced weight are among the features. All types in either 900, 1500 or 2500 lb sp classes.



Size Range—2½, 3", 4", 5", 6", 8", 10", 12" and 14".

For more data on these or other valves in the complete Edward steel valve line, write for Catalog 104. Or, if you indicate special interests in valves or various types, we can include special bulletins you will find helpful.

Another Product

Edward Valves, Inc.

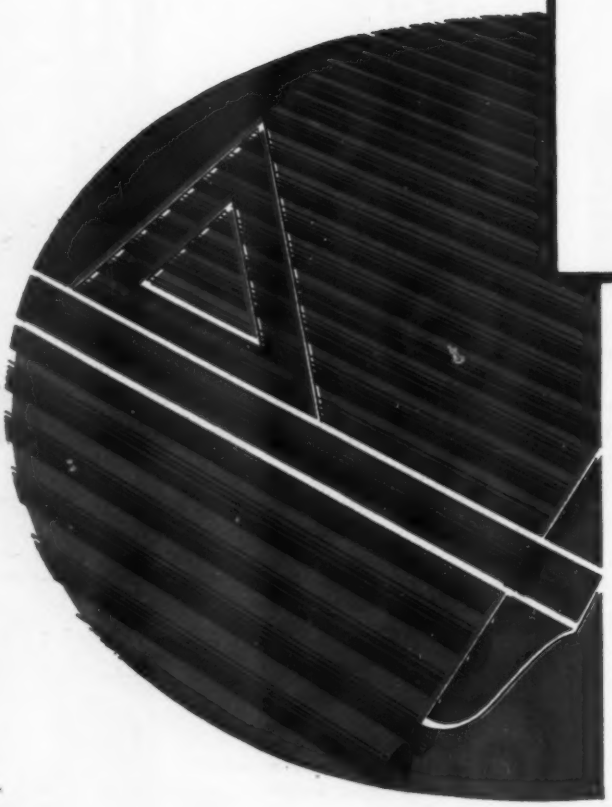
Subsidiary of ROCKWELL MANUFACTURING COMPANY

EAST CHICAGO, INDIANA

XUM

Why the *FIRST* names in pipelines depend on the *FIRST** name in line pipe

***FIRSTS by A. O. SMITH • Welded line pipe Internal expanded pipe • Light wall large diameter pipe • World's largest producer of large diameter welded steel line pipe**



● Creative engineering is a 76-year-old tradition at A. O. Smith. One of A. O. Smith's outstanding "firsts" is the internal expanding process that assures the roundness, straightness and accuracy of dimensions of A. O. Smith Line Pipe.

Here's what this means: line pipe is stressed beyond its yield point by uniform internal expansion—a process that produces higher yield strength. The result is line pipe that is lighter and stronger . . . yet requires no expensive alloy steel to obtain these desirable characteristics. It all adds up to a better line pipe that is simple and economical to weld—permits higher operating pressures—lower cost per mile.

A. O. Smith Line Pipe is available in a complete range of sizes and wall thicknesses, from 8⅝ in. to 36 in. in diameter.

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Inland Petroleum Transportation Co., Inc., one of the West's most successful and longest established firms specializing in the prompt and efficient delivery of petroleum products, has been a Kenworth customer for 15 years. R. J. (Monty) Monroe, general manager, says: *"The weight-saving advantages of Kenworth's Model 825 permit us to carry increased payloads, and this is one of the extra values we look for when purchasing trucks."*

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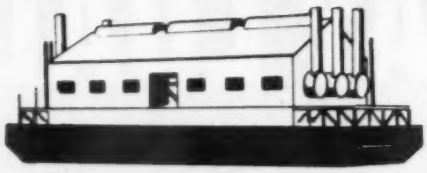

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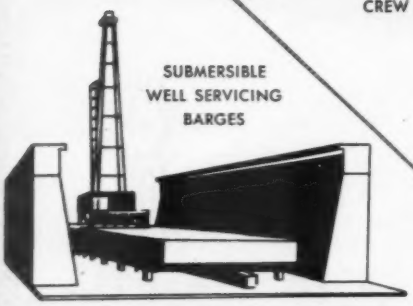

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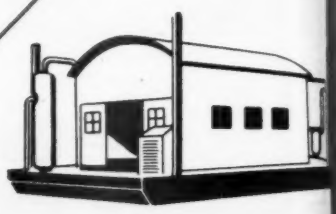

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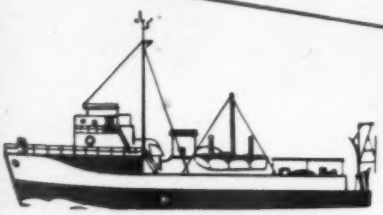

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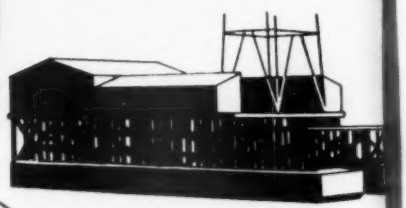
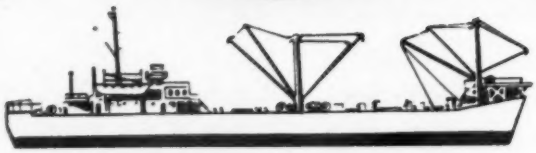


SUBMERSIBLE DRILL BARGES



OFF-SHORE DRILLING TENDERS—CONVERTED LST'S AND YF'S

Levingston

BUILDER OF FINE SPECIALIZED MARINE EQUIPMENT FOR THE PETROLEUM INDUSTRY

SALUTES THE AMERICAN PETROLEUM INSTITUTE ON THE OCCASION OF ITS 30TH ANNUAL CONVENTION

Levingston SHIPBUILDING CO. • ORANGE, TEXAS

XUM

Aldrich-Groff Constant Stroke Pump, used in conjunction with the Variable Stroke "POWR-SAVR" to provide the desired base volume of delivery.

Aldrich-Groff Controllable Capacity "POWR-SAVR" Pump, applicable throughout the Petroleum Industry, is available in 6 frame sizes ranging from 5 to 125 hp for pressures from 250 to 15,000 psi, and provides stepless, automatic control of delivery.

ELIMINATE LINE PRESSURE SWING

Maintain Maximum Pipe Line Efficiency...

By combining an Aldrich-Groff Variable Stroke "POWR-SAVR" Pump with either its companion Aldrich-Groff Constant Stroke Triplex Units or an Aldrich Multuplex Pump, you can automatically eliminate line pressure swing and safely maintain the maximum rate of delivery in your line at all times. You can also simplify pump station control and eliminate the expense and objectionable features of station surge tanks.

The development of Aldrich-Groff Variable Stroke and Constant Stroke Pumps—to embody *interchangeable fluid-end* and *principal power-end parts* — constituted another notable Aldrich "First". These units are serving on a number of modern high pressure pipe lines with the satisfactory results indicated by repeat orders.

Variable Stroke Pumping Capacity need only cover throughput variations incident to temperature and viscosity changes. The bulk of the installed capacity may be of the less expensive Constant Stroke Units. Such a multiple unit installation not only affords pumping flexibility and extreme reliability, but also lessens the investment for spare unit capacity. And, pumping units need only be installed to care for initial line capacity with additional units being added as the line demands build up. This means less initial investment expense and attainment of full load efficiency under all conditions, with consequent savings in pumping power.

Both types of units employ a *conventional fixed throw crankshaft* of solid forged steel construction which has proven to be best adapted for reliable continuous service, as attested by over 500 units installed so far—many with 10 year service records.

Both units feature self-contained reduction gear drive adapted to utilize an efficient high speed motor or turbine (for refinery service) mounted on the pump frame itself. This not only means compactness of floor space and savings in foundation and building costs—but assures accurate mechanical alignment at all times. V-Belt and other forms of engine drive are optional.

Write for Data Sheet 62 or for our representative to call.

Representatives: Birmingham • Bolivar, N. Y. Boston • Buffalo • Chicago • Cincinnati • Cleveland Denver • Detroit • Duluth • Houston Jacksonville • Los Angeles • New York • Omaha Philadelphia • Pittsburgh • Portland, Ore. Richmond, Va. • St. Louis • San Francisco Seattle • Spokane, Wash. • Syracuse • Tulsa

THE ALDRICH PUMP COMPANY

9 GORDON STREET, ALLENTOWN, PENNSYLVANIA

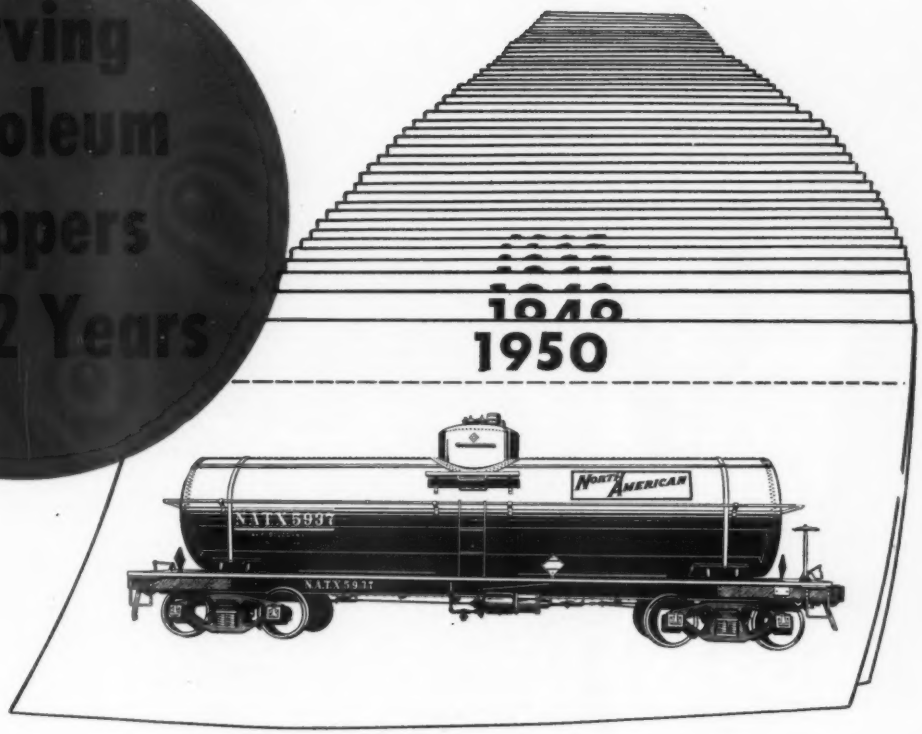
All Aldrich Pumps Have **STAYING POWER**

The identifying brand symbols on each Jones sucker rod serve a definite purpose. To the operator who keeps rod records, they are especially useful. In selecting the right rods to run in a particular well, they are no less important. But, there is a far more important meaning to the Jones brand. It stands for the leadership of more than half a century.

It symbolizes a long list of "firsts" from the first all-metal sucker rod down through well-studies and research and includes practically every major advance in rods and their use. It is instantly recognized by those in petroleum production as a mark of quality in sucker rods.

THE S. M. JONES COMPANY
Division of Buffalo-Eclipse Corporation
General Office and Factory: TOLEDO, OHIO
Sales Office: Kennedy Building, Tulsa, Okla.
Export Sales Office: Buffalo International Corp.
50 Church Street, N. Y. C.

Serving Petroleum Shippers for 42 Years



Solving intricate shipping problems of the petroleum industry has been a North American specialty since 1908. It's helped create our enviable nationwide reputation for the safe and economical movement of petroleum products to market.

Back of this specialized service stands (1) a fleet of tank cars scientifically designed for hauling petroleum, (2) a staff of seasoned authorities stragetically located in the leading market centers and, (3) hundreds of expert repairmen to maintain this equipment in top condition always.

No matter what your problem, our representatives can—and will—find the solution. Contact any of the offices listed below for prompt, efficient and careful consideration of your shipping needs.

FOR SPECIAL PRODUCTS REQUIRING SPECIAL CARE

NORTH AMERICAN CAR CORPORATION

NORTH WESTERN REFRIGERATOR LINE COMPANY

A NATIONWIDE ORGANIZATION WITH BRANCH OFFICES IN IMPORTANT MARKET CENTERS

231 South LaSalle Street, Chicago 4, Illinois

RIO GRANDE NATIONAL BLDG., DALLAS, TEXAS
341 KENNEDY BLDG., TULSA 3, OKLA.
739 PILLSBURY AVENUE, ST. PAUL 4, MINN.
681 MARKET STREET, SAN FRANCISCO 5, CALIF.
SHELL BUILDING, ST. LOUIS 3, MO.
60 EAST 42ND STREET, NEW YORK 17, N. Y.

XUM

THE price paid for Attapulgus and Porocel adsorbents is around *one cent* per pound—a fact which, we will agree, makes pretty dull reading. But for refiners using our materials, this modest investment pyramids to phenomenal returns. To be specific, each pound properly applied to petroleum stocks increases their value by at least *one dollar*—a return of 100 to 1.

Some four billion pounds of fullers earth and bauxite have been shipped to refineries by Attapulgus and Porocel —a noteworthy record of service to the industry. But what is even *more* noteworthy is the fact these materials have put four billion dollars into refinery purses—a point which makes *good* reading.

That's the record to date. It was accomplished by adsorbent-treating a wide variety of hydrocarbons to effect reduction or removal of colors, odors, tastes, moisture, sulfur, acids, fluorides and unsaturates, and for catalytic purposes. It's a record for *you* to tie to when considering plans to improve quality, expand output, or both.

Consult with us freely. Our broad knowledge of the behavior of our products under many sets of conditions should go far in helping *you* get 100 for 1.

ATTAPULGUS CLAY COMPANY *Fullers Earth* · **POROCEL** CORPORATION *Activated Bauxites*

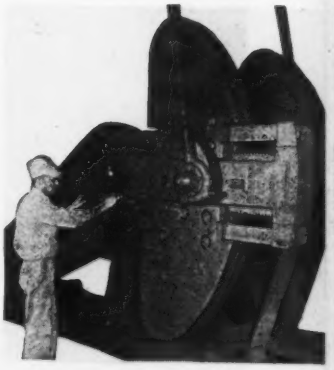
Dept. V, 210 West Washington Square, Philadelphia 5, Pa.

So Easy... So Safe!

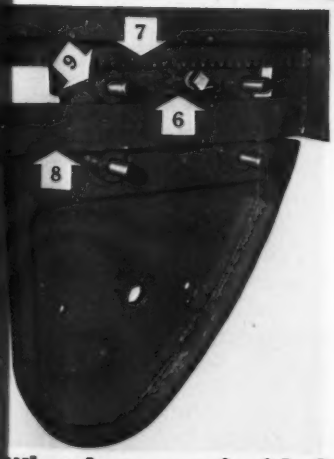
How the weights are shifted

Each of the four weight assemblies (two on each crank) consists of a heavy inner shell and a heavy outer shell (1) held together by four bolts and nuts. To change position of weights, first loosen nuts (2); then apply socket wrench to wrench square (3), turning clockwise or counterclockwise as the situation demands. This moves the entire weight assembly. Nothing to it! Numbered graduations on the crank facilitate adjustment.

If additional counterweighting is required, extra weights can be bolted inside the shells. They are held in place by bolts and nuts at points (4) and (5).



Safety! Only *one* crank position is needed for making counterweight adjustments. The operator stays on the ground... he isn't obliged to climb all over the unit. Nothing to move, nothing to slip, nothing to fall and injure him.



What happens inside?

View with outer shell removed. The wrench square (see 3, above) is part of a pinion (6) geared to a rack (7). As the pinion is turned, the weight assembly rolls smoothly along rail (8). Sturdy rollers (9) make this very easy.

For years field men have been demanding a pumping unit counterbalance that would combine simplicity with effectiveness—a system that could be adjusted EASILY, QUICKLY, and SAFELY when changes were required. Now it's here—in the Bethlehem Series 50 Pumping Units.

This Bethlehem innovation makes it possible to shift each weight in a matter of seconds, after four nuts have been loosened. A child can do it. It's foolproof, too . . . no hazards to endanger life or limb. For major details, study the three photographs shown on this page; then request a Bethlehem man to arrange a demonstration.

BETHLEHEM SUPPLY COMPANY

General Offices: 21 E. Second Street, Tulsa, Okla.

Subsidiary of Bethlehem Steel Corporation

On the Pacific Coast Bethlehem Oil-Field Equipment is sold by Bethlehem Supply Company of California

BETHLEHEM STEEL

XUM

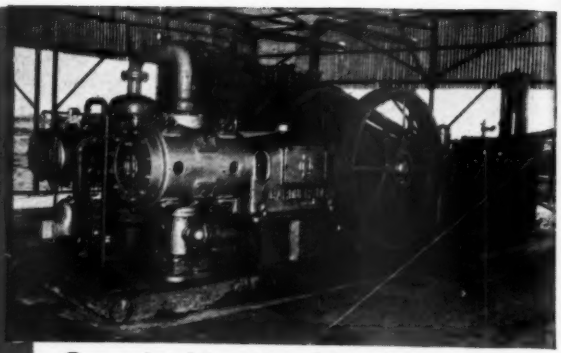
NOW... GARDNER-DENVER quality increases production in BOOSTER SERVICE RE-PRESSURING AIR-GAS LIFT

Packaged booster compressor units—featuring world-famous Gardner-Denver compressors—are now available in a wide range of capacities and pressure ratings from 5 to 275 h.p.

Check your requirements:

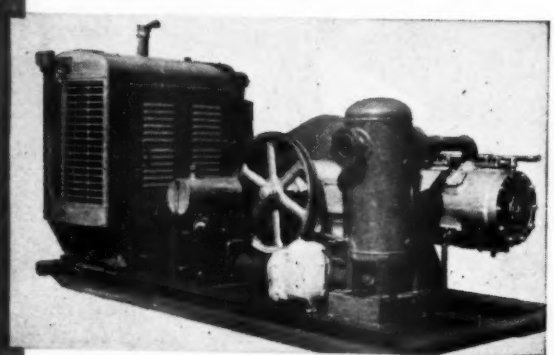
- Portable or stationary units
- Electric motor or gas engine drive
- Single-stage or two-stage units
- Vertical or horizontal compressors

Call your nearest Gardner-Denver office for complete details on any type or size, or write us for further information.

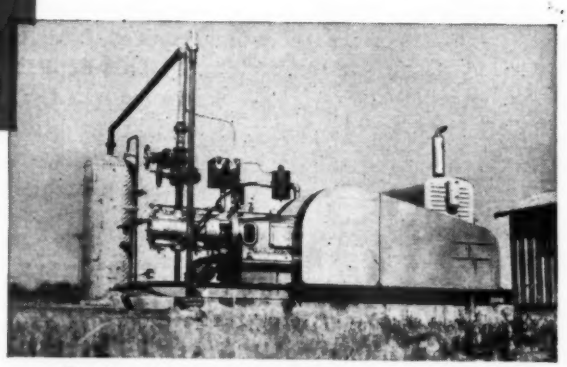


Gas engine driven 12 and 6 x 13 compressor for re-pressuring service.

Engine driven model ABE for re-pressuring or booster service.



Engine driven 8 x 9 gas booster compressor.



Engine driven 5½ x 9 booster compressor.

GARDNER-DENVER

Since 1859

Gardner-Denver Company, Quincy, Illinois
In Canada:
Gardner-Denver Company (Canada), Ltd., Toronto

Dallas • Houston • Tulsa • St. Louis • Los Angeles
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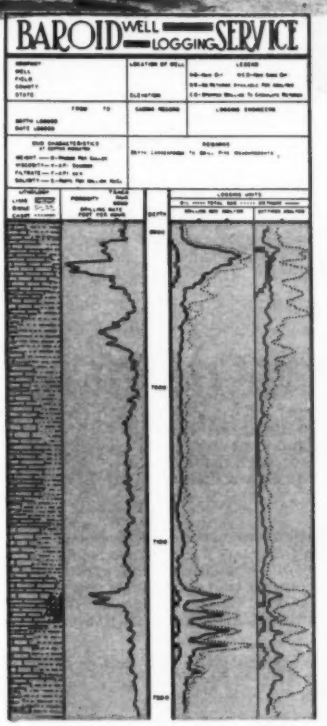
IN THE PERMIAN BASIN OPERATORS CHOOSE

BAROID WELL LOGGING SERVICE

TO MAKE SURE THEY DON'T PASS UP THE PAY!



In West Texas, interpretation of the fluid content of formation penetrated is extremely difficult. Operators in this area have found BAROID Well Logging Service to be an excellent indicator of oil and gas shows, porosity, permeability and the fluid content of formation.

Mud Analysis, Cutting Analysis and the Drilling Rate Curve combine with the on-location core analysis to provide the information desired for efficient wildcat operations. These Permian Basin operators know that Baroid Well Logging Service allows them to drill fast without passing up the pay zones.

you can rely on...

Baroid

BAROID SALES DIVISION
NATIONAL LEAD COMPANY
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Houston	CEntral 9371
Los Angeles	Michigan 1381
Tulsa	2-8161
Calgary, Alta., Canada	M1316

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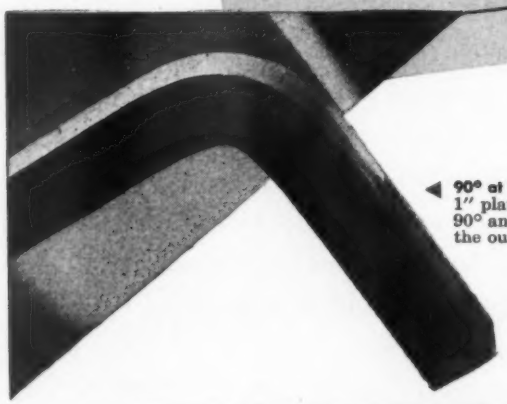
Announcing... U·S·S

A NEW HEAT-TREATED ALLOY STEEL WITH

MECHANICAL PROPERTIES—U·S·S Carilloy T-1 Steel can be furnished Heat Treated to the following mechanical properties:

	Thickness ¼" to 2" incl.	Thickness Over 2" to 4" incl.	Thickness Over 4" to 6" incl.
Yield Strength, 2% Offset (min.)	100,000 psi	90,000 psi	90,000 psi
Tensile Strength (min.)	115,000 psi	105,000 psi	105,000 psi
Elongation in 2", % (min.)	18	17	16
Reduction of Area, % (min.)	55	50	45
	Thickness ¼" to ½" incl.	Thickness Over ½" to 1" incl.	Thickness Over 1" to 2" incl.
Cold Bend	180°D=1t	180°D=2t	180°D=3t

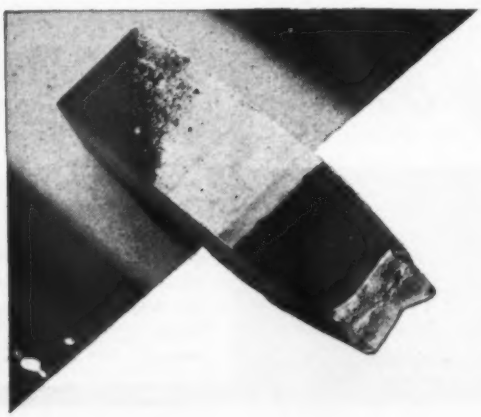
(Testing in accord with A.S.T.M. recommended practices.)

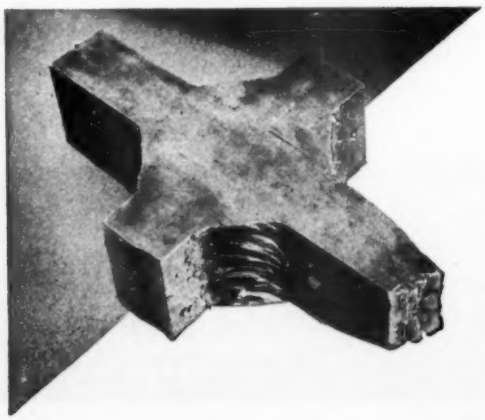


Look at these test results:

◀ **90° at 98 below!** The sample here was flame-cut from 1" plate. Then it was chilled to –98°F, and bent to a full 90° angle. Even though the raw, flame-cut edge made up the outer radius of the bend, there was no sign of failure!

▼ **100% WELD STRENGTH**—Tensile tests on welded specimens like these prove that welds on CARILLOY T-STEEL are 100% efficient. Welds develop the *full* strength of the parent metal. Note that breaks occur outside the heat-affected zone. No special pre-heating or post-heating treatments are required beyond those used with ordinary structural steels.





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Carilloy T-steel

THIS REMARKABLE COMBINATION OF PROPERTIES

1. High yield strength of 100,000 psi minimum.

2. Strong and ductile even at 100 below zero!

3. Readily weldable - - without loss of strength or ductility.

HERE is a new alloy steel developed especially for heavy-duty equipment that must withstand a lot of abuse in all sorts of climates — in the scorching heat of summer and the bitter cold of winter — yet with all this, it's a steel that can be easily gas-cut and readily welded.

U·S·S CARILLOY T-STEEL was developed by Carnegie-Illinois research. It provides a unique combination of superior strength and unusual ductility. This low carbon *alloy* steel can actually be welded and gas-cut as readily as structural *carbon* steel.

Plates of CARILLOY T-STEEL from ¼" up to 2" in thickness have a minimum yield strength of 100,000 psi even *after* welding and gas-cutting. Despite this very high strength, T-Steel will remain tough and ductile at any climatic temperature. That's why CARILLOY T-STEEL is made to order for heavy-duty equipment that must operate out-in-the-open under high impact loads and without danger of failure.

The *full* strength of CARILLOY T-STEEL can be utilized in designing welded construction because the high physical properties are not affected by welding or gas-cutting.

U·S·S CARILLOY T-STEEL has been developed for use in the form of plates and bars. Its nominal hardness is 250 Brinell. For abrasive conditions, where high hardness *and* toughness and weldability are essential, hardness up to 320 Brinell minimum can be furnished.

SEND THE COUPON

Carnegie-Illinois Steel Corporation
Room 4209, Carnegie Building
Pittsburgh 30, Pa.

Please send me a copy of the Carilloy T-Steel booklet.

Name.....

Company.....

Address.....

City.....Zone....State.....

CARNEGIE-ILLINOIS STEEL CORPORATION, PITTSBURGH

COLUMBIA STEEL COMPANY, SAN FRANCISCO • TENNESSEE COAL, IRON & RAILROAD COMPANY, BIRMINGHAM

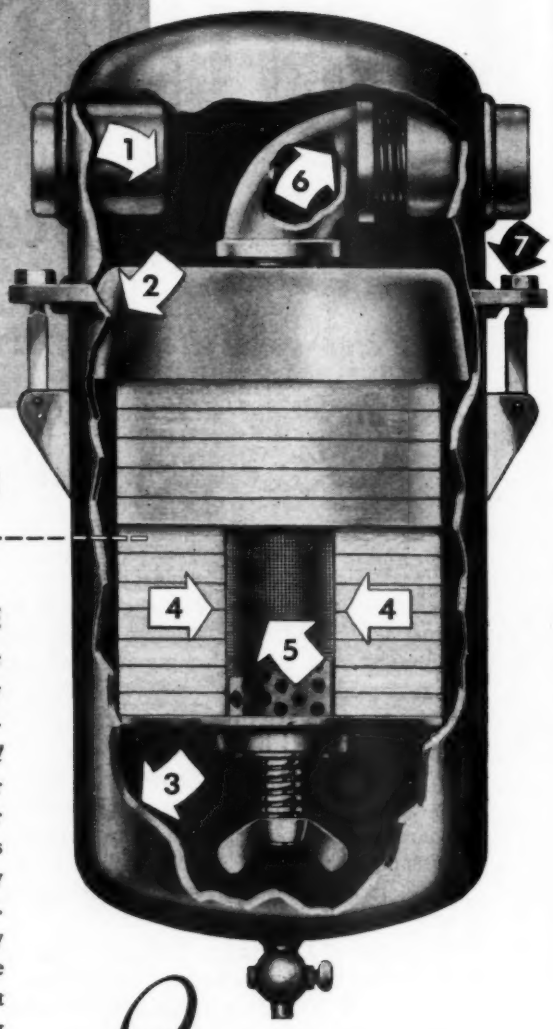
UNITED STATES STEEL SUPPLY COMPANY, WAREHOUSE DISTRIBUTORS, COAST-TO-COAST • UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS Carilloy Steels

ELECTRIC FURNACE OR OPEN HEARTH • COMPLETE PRODUCTION FACILITIES IN CHICAGO AND PITTSBURGH

UNITED STATES STEEL

Removes Last Traces of Oil and Moisture from COMPRESSED AIR LINES



THICK FELT DISCS PROVIDE SUPER FILTRATION

DOUBLE ACTION PRINCIPLE REMOVES MOISTURE AND DIRT TWO WAYS—Here's the greatest pipe line filter ever developed for removal of every trace of foreign matter, condensed oil and moisture. Compressed air is cleaned by both *mechanical separation* and *filtration/absorption.* Air entering filter inlet (1) strikes Deflector Cup (2) by which heavier droplets of water and dirt particles are directed to sides of Housing (3) and thence downward at high velocity to base where liquid and heavier particles are deposited. The *mechanically cleaned* air then passes at low velocity thru the Discs (4) which *filter* the air and *absorb* the last traces of oil and moisture. Clean, dry air passes out thru fine mesh Bronze Screen (5) and Outlet (6). Swing Bolts (7) on head for easy inspection are optional.

Originally designed for the protection of pneumatically operated control apparatus, these revolutionary filters are now used as a primary or final stage of filtration for an ever-increasing number of tools, devices and processes. Many highly successful installations are reported in which no other filter had proven satisfactory.

Request Bulletin B-1A, mentioning problem involved for specific engineering information. Please direct your inquiry to Dept. 5.

Staynew

ABSORPTION FILTER

A complete range of sizes available, handling capacities from 5 to 100 CFM free air at 80 lbs. gauge pressure in standard pipe sizes from ¼" to 2". Model illustrated is AAPHS (swing-bolt head). Available also is Model AAPH, identical except for bolted-head construction.

DOLLINGER REG PROTECTOMOTOR U.S. PAT. OFF STAYNEW FILTERS

DOLLINGER CORPORATION
11 CENTRE PK., ROCHESTER 3, N. Y.

XUM

3 essentials for Drill Collars

Uniform hardness, straightness and concentricity are assured in CP Drill Collars because of the exacting methods employed in their manufacture.

Forged from chrome-nickel alloy steel, CP Drill Collars are overall hardened by vertical quenching to assure straightness and freedom from distortion strains . . . bored on machines recently designed and developed exclusively for Chicago Pneumatic, which produce mirror-like finish bores, with a straightness and alignment never previously possible . . . finish turned on the outside concentrically with the bored hole.

Connections on drill collars are furnished to customer's specifications. Popular size drill collars are carried in stock for immediate delivery, and other lengths, up to 55 feet, can be supplied on special order.

CHICAGO PNEUMATIC TOOL COMPANY

MANUFACTURED AT FRANKLIN, PA.

GENERAL & EXPORT OFFICES: 6 EAST 44th STREET, NEW YORK 17, N. Y.

Oil Tool Sales Office: One N. W. 16th Street, Oklahoma City, Oklahoma
In Canada: 10103 Eighty-First Avenue, South Edmonton, Alberta, Canada

Constructed to Take Severe Punishment

Without Tube Swelling

CONCORD #20 STEAM HOSE

Here's the steam hose with a structural difference that eliminates . . . once and for all . . . the common failure of tube swelling under continuous high pressure operation.

CONCORD #20 Steam Hose gives you the exclusive protection of a tough inner lining . . . a lining of stainless steel wire braid. This braid assures permanent retention of the original inside hose diameter. It prevents swelling and constriction of the tube . . . assures full flow of steam at all times . . . permits re-coupling in the field when necessary, without the slightest difficulty.

In addition, CONCORD #20 construction features include: two or three braids (depending on size) of alternate high tensile steel wire and rubber layers are firmly bonded over the outside of the tube. They provide maximum burst-protection and safety. An asbestos braid provides positive cover adhesion and serves as cover insulator. On top of all is the rugged, abrasion-resistant cover that withstands the severest abuse.

Flexible, tough and dependable . . . that's BWH's new CONCORD #20! Ask your nearby BWH distributor for a demonstration. Get in touch with him today, or write us direct.

BWH
DEPENDABLE RUGGEDNESS

Tube Securely Locked by Special Stainless Steel Inner Wire Braid!

Illustration above shows how exclusive inner stainless steel braid of CONCORD #20 Steam Hose prevents tube swelling and assures long life under severe use.

Another Quality Product of

BOSTON WOVEN HOSE & RUBBER COMPANY

Distributors in all Principal Cities

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The New Alfco Model 350

INDUSTRY'S BIGGEST WHEELED PORTABLE

DRY CHEMICAL ENGINE

It is one of the most efficient, fast-acting, fire extinguishing units which Alfco engineers have yet devised. Containing 350 lbs. of Alfco Dry Chemical, the smothering action of its deadly discharge on fire is sensational.

Blistering hot fires of considerable proportions which at first may appear too monstrous for control, can be quickly extinguished.

Its discharge pattern is fan shaped. The density of the dispersion of the Dry Chemical is total! Effective range is 20 to 25 ft. Expelling agent is *dry* nitrogen. Discharge time is about 1 min., 15 sec. Dry Chemical is nontoxic, noncorrosive, a nonconductor of electricity and will not freeze.

Approved by Underwriters and Factory Mutual Laboratories. Rating B, C.

Write for illustrated literature

OUR 2nd Century of Leadership in FIRE PROTECTION

AMERICAN-LAFRANCE-FOAMITE Corporation

ELMIRA NEW YORK U.S.A.

ALFCO

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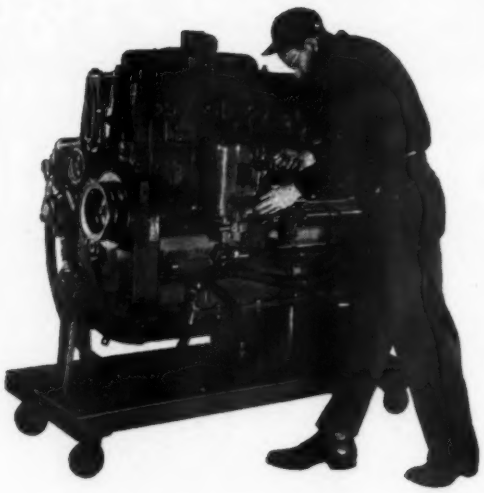
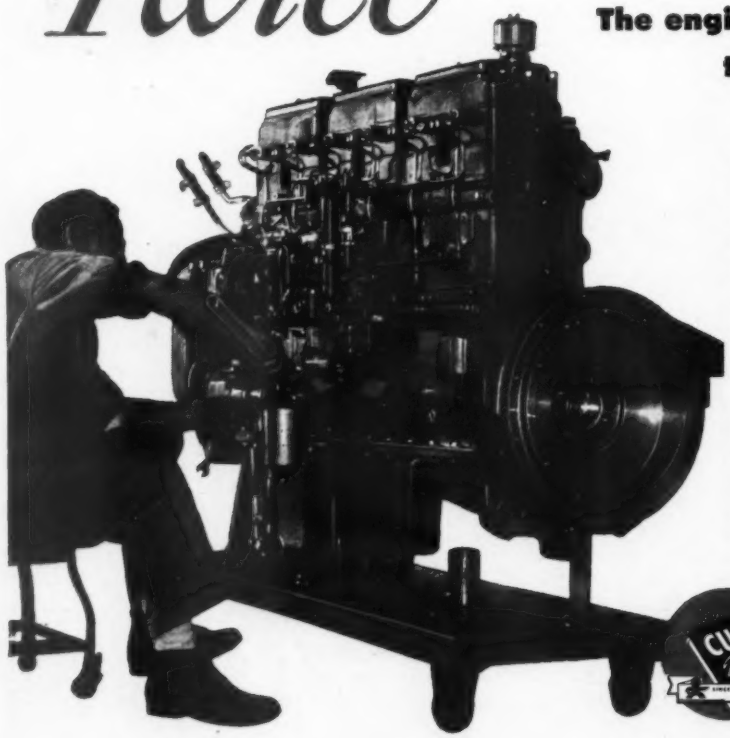
Cummins® Custom-built Diesels

Built not once but Twice





The engine that's built better to give power at lower cost

Why is a lightweight, high-speed Cummins Diesel the best buy in economical, dependable power? *Because every* part of *every* engine is made under strictest quality control methods. Each engine also is actually built *twice*. After initial assembly, each engine is run-in on the test block. Then it is torn down and carefully re-inspected—after that it is re-assembled and tested *again*.

Perfection in engine craftsmanship . . . Cummins exclusive fuel system . . . an unexcelled service and parts organization . . . mean that rugged, dependable Cummins Diesels make more profits for power users.

There's a model for your power needs. Contact your Cummins dealer. He has more facts to show you about making more profits with

Diesel power by CUMMINS

CUMMINS Diesel DIESEL

TRADEMARK REG. U.S. PAT. OFF.

CUMMINS ENGINE COMPANY, INC. · COLUMBUS, IND.

EXPORT: CUMMINS DIESEL EXPORT CORPORATION
Columbus, Indiana, U.S.A. · Cable: Cumdiex

Lightweight High-speed Diesel Engines (50-550 hp) for: On-highway trucks · off-highway trucks · buses · tractors · earth-movers · shovels · cranes · industrial locomotives · air compressors logging yarders and loaders · drilling rigs · centrifugal pumps generator sets and power units · work boats and pleasure craft.

LOOK AT THIS ECONOMY RECORD

with a Bucyrus-Erie 28-L Spudder owned by Ford Oil Co., Holland, Michigan:

In 23 months of 24-hour operation — drilled 47 top-to-bottom wells averaging 1,500 ft. in depth, drove six carloads of 8-in. drive pipe — spent only $380 for repairs . . . *including* $200 for engine overhaul!

No wonder Glenn Mannes, owner of the Ford Oil Co. says "I like the machine 100%. Well satisfied!" "Drilling 47 wells in 23 months," he adds, "is remarkable for this part of Michigan where the general ground formations are drift and gray, green and brown shale." And you'll agree that a repair bill of only $380 for 23 months of 24-hour operation is a remarkable maintenance record — one that's hard to beat even in easy going!

This is the kind of economy, dependability, and output that has made Bucyrus-Erie spudders favorites among cable-tool men everywhere. Performance like this can make *your* drilling, well completion, or workover jobs pay bigger profit dividends. See your Bucyrus-Erie spudder distributor for all the facts!

BUCYRUS-ERIE CO.
South Milwaukee, Wisconsin

Pictured at the "business end" of the 28-L Spudder are owner Glenn Mannes (right) and operator J. B. Cheers. 70550 A

See or Write Your BUCYRUS ERIE Spudder Distributor

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XUM

portrait

OF A LUNKENHEIMER STEEL CASTING

Short-wave Gamma rays search the steel of Lunkenheimer castings—probing for defects — making sure that the Lunkenheimer valves *you* buy are *sound all the way through.* Notice the smooth, even structure shown in this radiographic film. It is an x-ray portrait of steel valve strength, free from the telltale localized shadows that mark internal danger spots.

Radiography is only one of the many test-procedures that insure *high quality* for Lunkenheimer steel valves. All pressure-parts for large steel valves are given a Magnaflux test in addition to their regular visual inspection. And every steel valve is tested far in excess of rated pressures.

When you buy Lunkenheimer steel valves, you get *more* than mere pressure-tightness. Lunkenheimer engineers are not satisfied with meeting minimum specifications; they are interested in attaining the soundest possible metal structure in every section. That's why Lunkenheimer valves last — and last.

For detailed information on the metals and trim that will best serve *your* valve requirements, get in touch with your nearest Lunkenheimer representative. Or write The Lunkenheimer Company, Box 360F, Cincinnati 14, Ohio.

STEEL . . . IRON . . . BRONZE

LUNKENHEIMER

THE ONE *Great* NAME IN VALVES

L-1050-S

extra service for your equipment when "WEAR-RESISTED" with AIRCO hardfacing alloys

Because of the hardness and other desirable characteristics of these alloys, they provide high resistance to all types of wear—abrasion . . . impact . . . heat . . . corrosion. One application often adds 2 to 25 times longer service life to *worn or new* parts . . . big dividends in savings of "down-time" and replacements.

There is an Airco alloy available for oxyacetylene flame or electric arc application to meet all types of wear conditions.

1. ***Severe abrasion and medium impact***
2. ***Shattering impact and abrasion***
3. ***Severe impact and abrasion***
4. ***Sliding abrasion and impact***
5. ***Extreme earth abrasion***
6. ***Corrosion and heat***

Constant research is developing new alloys to meet special wear problems as they occur.

If you have parts or tools subject to any type of wear, it will pay you to investigate the savings you can make in maintenance and replacement costs by using Airco Hardfacing Alloys.

For further information about Airco's complete line of "wear-resistant" alloys, write your nearest Airco office or Authorized Dealer for a free copy of the Hardfacing Alloys Catalog.

More news about AIRCO products

FOR SEVERE IMPACT AND RESISTANCE TO ABRASION
Airco No. 388 Electrode

A shielded arc electrode sufficiently high in alloy content to produce a deposit bearing approximately 9% chrome and 0.9% carbon. This alloy content results in a weld metal deposit which is essentially martensitic.

Operators will find that the exceptionally fine arc action of Airco No. 388 increases both the speed and quality of their work.

FOR RESISTANCE TO EXTREME EARTH ABRASION
Airco Tungtube
Nos. 8, 10, 20, 30 and 40

These are fabricated rods of tungsten carbide particles encased in a steel sheath. The various Tungtube numbers indicate the screen size of the tungsten carbide particles contained within the tube. With its extreme hardness tungsten carbide ranks second only to the diamond in earth cutting efficiency. It is accepted as the standard means of cutting non-metallic substances; such as, coal, shale, and granite. It is recommended for core bits, fishtail bits, road plows, coal cutter knives, plow shares and similar equipment subjected to extreme earth abrasion.

CORROSION — ACID RESISTANT ALLOYS FOR WELDING HARDER GRADES OF ALUMINUM BRONZE
Airco Nos. 100, 116, 120, 125 and 130 Electrodes

For joining aluminum bronze or other metals and combinations of dissimilar metals—and for overlays on bearing surfaces, machine parts, dies, etc. The deposits made with these electrodes are corrosion and acid-resistant and will also retard wear from abrasion and impact.

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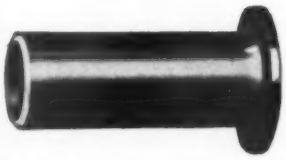
TO DO A BETTER PIPING JOB...



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PRECISION PROCESS SEAMLESS WELDING FITTINGS

Your preference for Globe Welding Fittings is supported by a source of supply with exceptional qualifications. Specialized metallurgical experience and facilities gained in years of steel tubing manufacture enable Globe to produce welding fittings by a precision process that yields a superior product.

Send for the Globe Welding Fittings Catalog No. 501.

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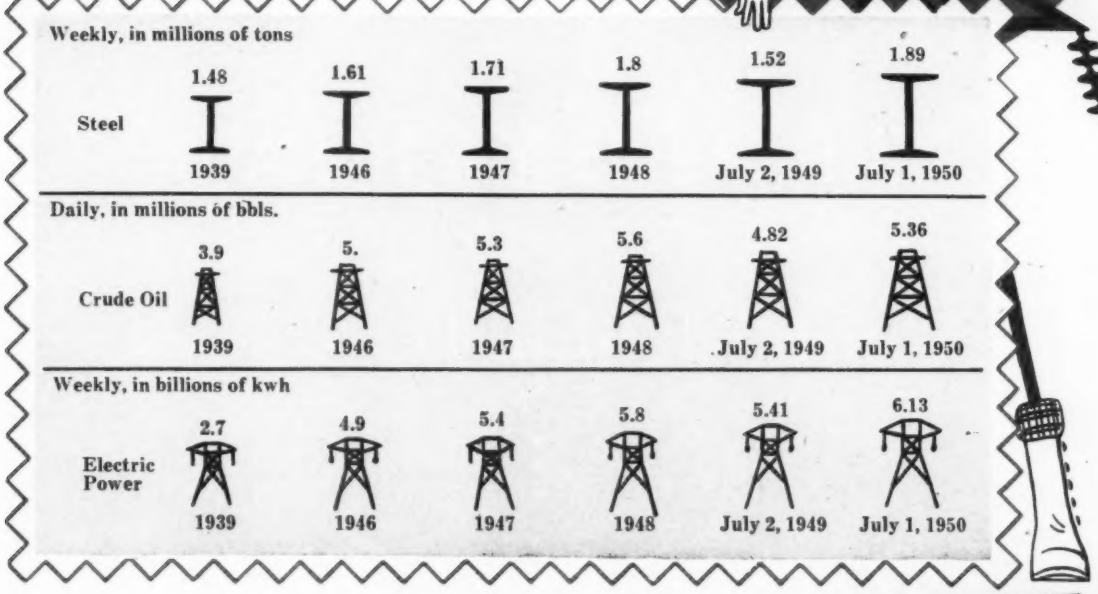
Producers of Globe Seamless Stainless Steel Tubes —Gloweld Welded Stainless Steel Tubes—Carbon — Alloy — Seamless Steel Tubes — Globeiron Seamless High Purity Ingot Iron Tubes and Pipe.

SIZE RANGE OF GLOBE SEAMLESS WELDING FITTINGS

Description of Fitting	Standard Weight (Schedule 40)	Extra Strong (Schedule 80)	(Schedule 160)	Double Extra Strong
Elbows 45° Long Radius	½ in. to 24 in.	¾ in. to 24 in.	1 in. to 12 in.	1 in. to 8 in.
Elbows 90° Long Radius	½ in. to 24 in.	¾ in. to 24 in.	1 in. to 12 in.	1 in. to 8 in.
Elbows 90° Short Radius	1 in. to 24 in.	1½ in. to 24 in.	- - -	- - -
Returns 180° Long Radius	½ in. to 24 in.	1 in. to 24 in.	1 in. to 12 in.	3 in. to 8 in.
Returns 180° Short Radius	1 in. to 24 in.	1½ in. to 24 in.	- - -	- - -
Reducers (Concentric and Eccentric)	1 x ⅜ in. to 24 x 20 in.	1 x ⅜ in. to 24 x 20 in.	1 x ⅜ in. to 12 x 10 in.	1 x ⅜ in. to 12 x 10 in.
Tees Straight	¾ in. to 24 in.	¾ in. to 24 in.	1 in. to 12 in.	1 in. to 8 in.
Tees Reducing Outlet	¾ in. to 24 in.	¾ in. to 24 in.	1 in. to 12 in.	1 in. to 8 in.
Stub Ends Lap Joint	1 in. to 24 in.	1 in. to 24 in.	- - -	- - -
Caps	1 in. to 24 in.	1 in. to 24 in.	1 in. to 12 in.	1 in. to 8 in.

Flanges available 1 inch to 24 inches in all weights

LCP* HEADS MAJOR BUSINESSES IN *Upward Trend*



Production statistics from U. S. Dept. of Commerce

THE OIL INDUSTRY USES LCP* MORE AND MORE EVERY DAY

On July 1, 1950, the average weekly electric utilities output was 6.13 billion kilowatt hours — exceeding the percentages of production of steel and crude oil. Yes, Sir — that's me we're talking about — *LCP! Management has recognized my advantages and put me to work! The Power Engineer of your Utility Electric Power Company can tell you — I cost less to install, less to maintain, and I cut your payroll, too! See how I've proved myself the LOW COST POWER for the oil industry!

***Low Cost Power**

PETROLEUM ELECTRIC POWER ASSOCIATION

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FOREMOST

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FACTS YOU SHOULD KNOW . . . about

G-E 2-Way Radio

NARROW BAND vs. WIDE BAND

• Narrow band equipment (20 kc channels in the 25-50 mc band) is ALLOCATION INSURANCE. It is almost inevitable that future geographical assignment plans made by industry advisory groups will be drawn up on a 20 kc channel separation basis. Installation of 20 kc equipment NOW protects your system against interference from same-area stations 40 kc off your own frequency and from skip signals only 20 kc removed from your channel. It would be to your advantage to consider a change-over now.

Extended field and lab tests show:

1. There is no discernible difference in communication range between 20 kc and 40 kc systems.
2. Lower multiplication factor in 20 kc transmitters means substantial reduction of spurious radiations.
3. Signal-to-noise ratio differences in high signal level areas are insignificant.

• You'll find more true, high-selectivity General Electric 20 kc units in service than all other makes combined. And G. E. also manufactures high-performance units for expansion of present systems where continued operation on a 40 kc channel basis is desired.

Instant communication for wide-area operations is our specialty. There's a radio communication representative at the G-E office near you. Ask him for full details. Meanwhile, write for some interesting new literature on microwave equipment: General Electric Company, Section 8110-16, Electronics Park, Syracuse, New York.

GET THIS BULLETIN—Bulletin X55-752 is important to every communications engineer. Write for your copy: *General Electric Company, Section 8110-16, Electronics Park, Syracuse, New York.*

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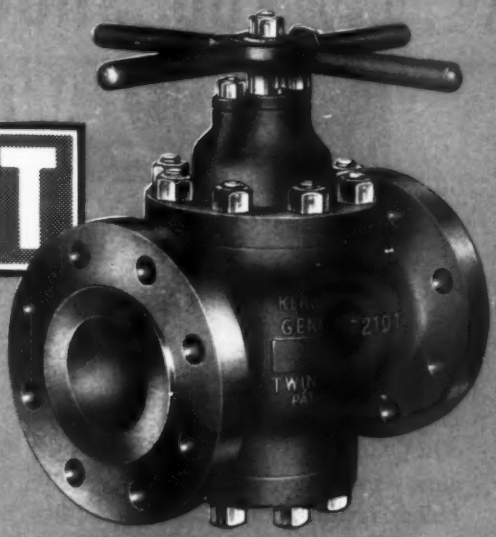
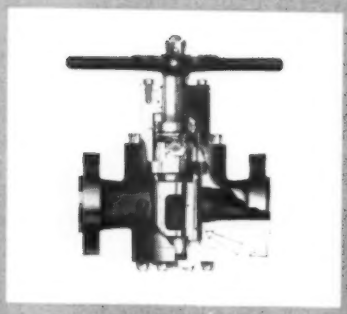
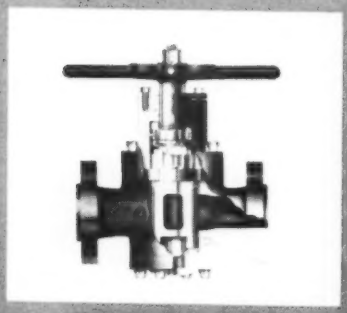
KEROTEST



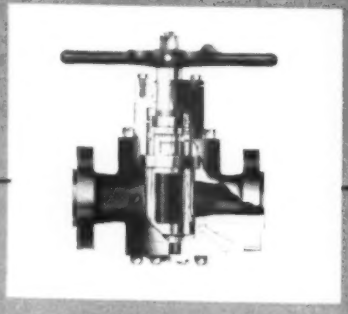
GENERAL
TWIN SEAL VALVE
VAPOR-TIGHT SEAL!



POSITION I—Plug down . . . seats expanded against body ports . . . valve full closed.



POSITION II—Plug raised . . . seats retracted clear of body wall . . . free rotation . . . no scoring.



POSITION III—Plug rotated 90° . . . valve full open.

Here is a new expanding seat, tapered plug valve that assures positive vapor-tight shut-off in either flow direction for gas or volatile liquid service. One and a quarter turns operates from full open to full closed position. No lubrication is required. Nothing to score, gall or wear. Renewable seats are replaced quickly through bottom plate. For easy operation . . . positive shut-off and freedom from maintenance, specify the Kerotest General Twin Seal Plug Valve.

1. **SHUTS OFF *VAPOR-TIGHT***
2. **EASY TO OPERATE**
3. **NO LUBRICATION**
4. **QUICK (1¼ turns) OPERATION**
5. **NO SCORING OF SEATS**
   (Seats rotate free of body wall)

WRITE for descriptive booklet giving size and pressure range, and full specifications.

KEROTEST MANUFACTURING CO.
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NOW it's proven!

A PORTABLE-PRACTICAL GEO-LOGGER

THE ELECTRIC WELL-LOGGING UNIT

that is

RUGGED, OPERATOR-PROOF, LOW COST, FAST and ACCURATE

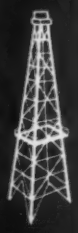
GEO-LOGGER

cuts the cost of information out of every shot or core hole of 1500 feet or less. After two years of development and testing, the portable, operator-proof Geo-Logger is ready to save you time and money. OK'd for design, performance and results by geologists and geophysicists who have seen Geo-Logger in operation.

GEO-LOGGER FITS YOUR PASSENGER CAR

No extra vehicle: Geo-Logger is compact, fits inside trunk compartment of any average passenger car, can be mounted on shooting truck or pick-up. Single aluminum case 18" high, 26" long, 14" wide. Powered by extra belt-driven generator, under hood of car or truck, just above regular generator.

SAVE PERSONNEL, TIME, MONEY

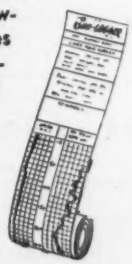


No extra man: Geo-Logger can be set-up and log made by one member of drilling crew. **No extra time:** Geo-Logger gets log of average shot hole (200 feet) in less than 5 min. elapsed time, from start of set-up to out of the hole and out of the crew's way. On a 700-ft. strat test—20 min. elapsed time.

- *EASY TO CARRY*
- *EASY TO USE*
- *EASY TO REPAIR*
- *EASY TO BUY*

ACCURATE, LOW-COST LOGGING COMPARABLE TO SERVICE COMPANY RESULTS!

The Geo-Logger gives you electric logs showing resistivity and self potential curves in holes up to 1500 feet; accuracy in every way comparable to service company logs, obtained at a fraction of their cost. Aids in picking proper position for shot, serves the interpreter of seismic records and locates water supplies for operating departments. The Geo-Logger will stretch current logging budgets; will make possible logging that, heretofore, could not be afforded.



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For further information, write

GEO-LOGGER,
5535 Yale Blvd.,
DALLAS, TEXAS

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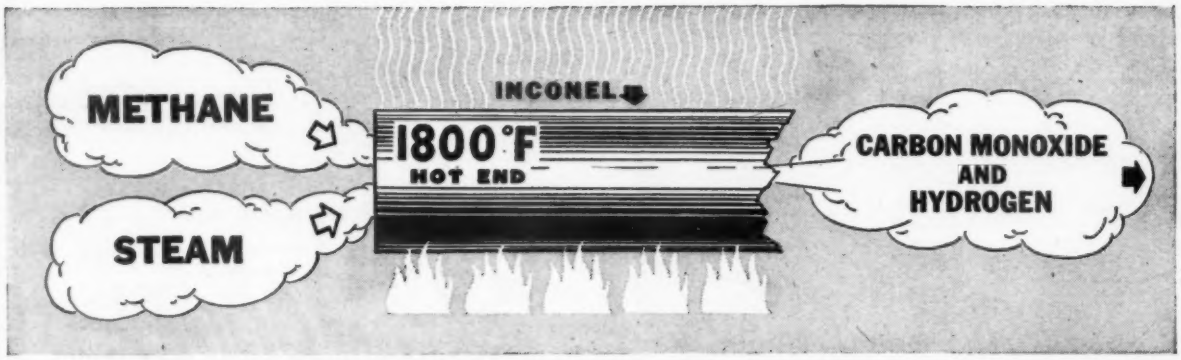
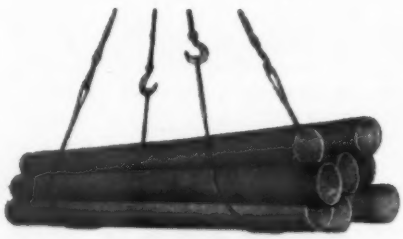


Hydrocarbon Synthesis—FROM METHANE AND STEAM

WILL INCONEL BE THE ANSWER TO THE HIGH TEMPERATURE PROBLEM?



LARGE DIAMETER EXTRUDED INCONEL TUBING IN VARIOUS SIZES!

You can order extruded Inconel tubing in outside diameters from 2½" to 9¼"; wall thicknesses from ¼" to ¾". Length varies according to diameter; ranges from 6' to 22'. For closer tolerances and thinner walls, sizes up to 4½" O.D. are produced by cold drawing. Write for complete information.

Inconel* is rightly regarded as one of the outstanding metals for resistance to high temperatures.

Now the questions are being asked: *Is Inconel the answer to the hot-end of hydrocarbon synthesis? Will Inconel have a service life measured in years rather than hours?*

Already On Trial

Nobody can say—but at least one manufacturer is using Inconel tubing for experiments in fuel synthesis from methane and steam. In this particular case, the components enter the synthesizer hot-end at a temperature close to 1800° F., passing through an Inconel tube that is heated on the outside by the combustion of methane. Inside surfaces of the tube operate continuously under carburizing conditions; the outside is exposed to severe oxidizing conditions.

Inconel was chosen because of its proved hot-strength and resistance to creep and carburization.

Other High Temperature Service

Inconel has been used successfully by heat treaters in both strongly oxidizing and reducing conditions...at temperatures up to 2000°F. Inconel fixtures serving over two years are still in excellent operating condition.

REMEMBER *Inconel when you're looking for materials to resist carburization and oxidation at high temperatures in hydrocarbon synthesis. Turn some of your problems over to our Technical Service. These men know what has been done (and what is being done) to provide durable metals for your kind of work.*

EMBLEM OF SERVICE
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THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street, New York 5, N. Y.

Inconel*—FOR LONG LIFE AT HIGH TEMPERATURES

*Reg. U. S. Pat. Off.

DESIGNERS and MANUFACTURERS! Sand castings and precision castings of Monel*, Nickel, Inconel* and other Nickel alloys are available from Inco's own foundry, backed by a half century of experience with Nickel and Nickel Alloys.

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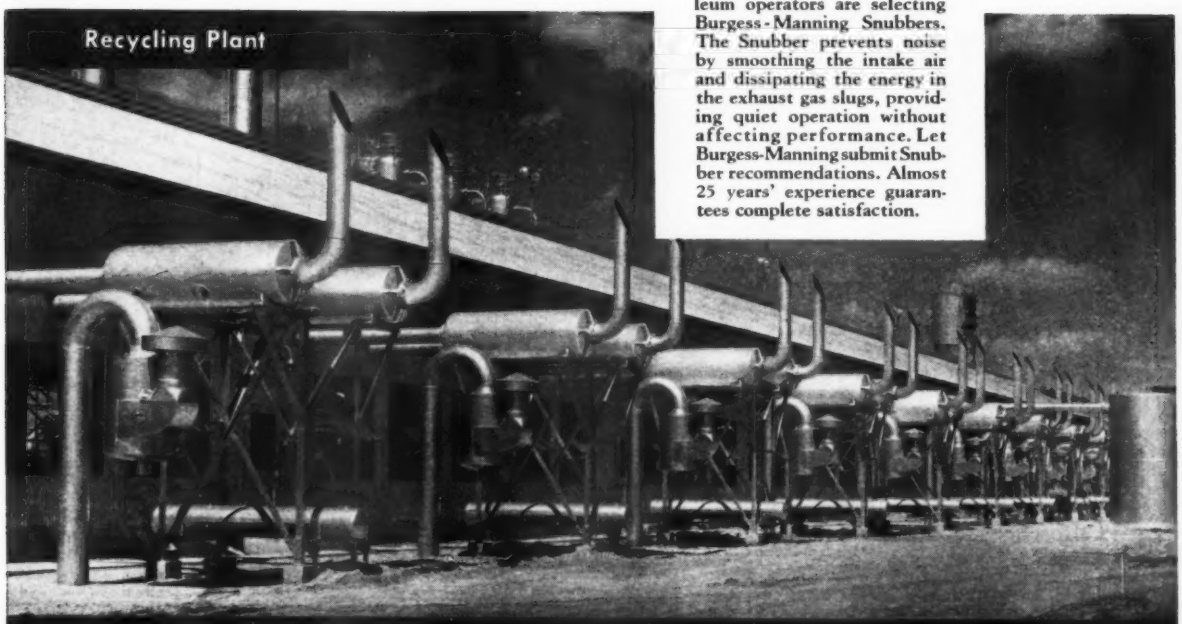
Snub the Slug—and Stop the Noise

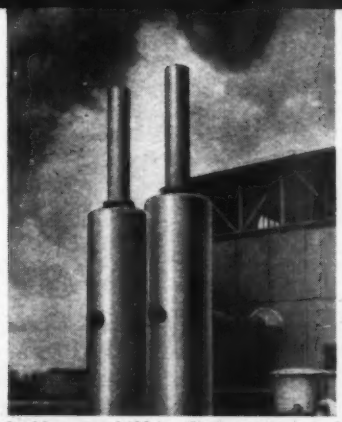
FROM ENGINE EXHAUSTS AND COMPRESSOR INTAKES

Wherever noise from internal combustion engines, compressors, blowers, vacuum pumps, cannot be tolerated; where flying sparks must be eliminated; for surge control in gas and air piping, petroleum operators are selecting Burgess-Manning Snubbers. The Snubber prevents noise by smoothing the intake air and dissipating the energy in the exhaust gas slugs, providing quiet operation without affecting performance. Let Burgess-Manning submit Snubber recommendations. Almost 25 years' experience guarantees complete satisfaction.



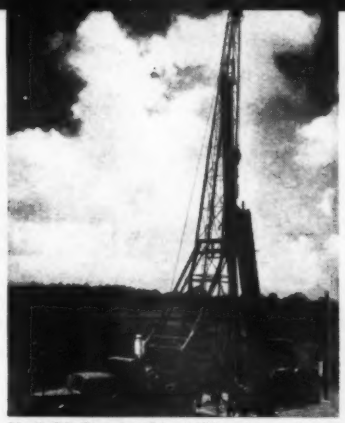
Recycling Plant

Main Line Gas Booster



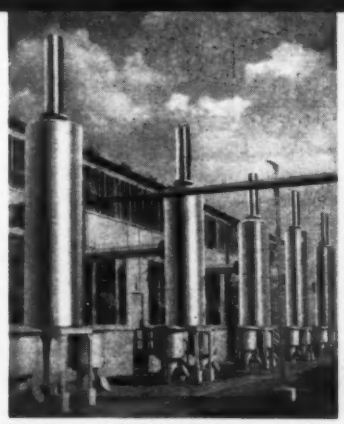
Snubbers on 1600-hp Clark engines used on a main line gas booster station.

Portable Drilling Rig



Shell Oil Co. portable drilling rig equipped with a Snubber.

Pipe Line Compressing Plant



Snubbers on 800-hp compressor engines of the Panhandle Eastern Pipe Line Co.

For Quiet Telephoning—Use Burgess-Manning Acousti-Booths

You can hear easily . . . talk comfortably . . . in a Burgess-Manning Acousti-Booth, even with intense noise. Thick walls of sound-absorbent material soak up noise. Airy, easily moved, sturdy construction.

INSTALLATIONS—

- Stationary and portable internal combustion engines
- Steam discharge
- Positive displacement and reciprocating vacuum pump discharge

APPLICATIONS—gas transmission • repressuring • recycling • refineries • gasoline plants • drilling • oil well pumping • crude oil and product pipe lines.

BURGESS-MANNING COMPANY

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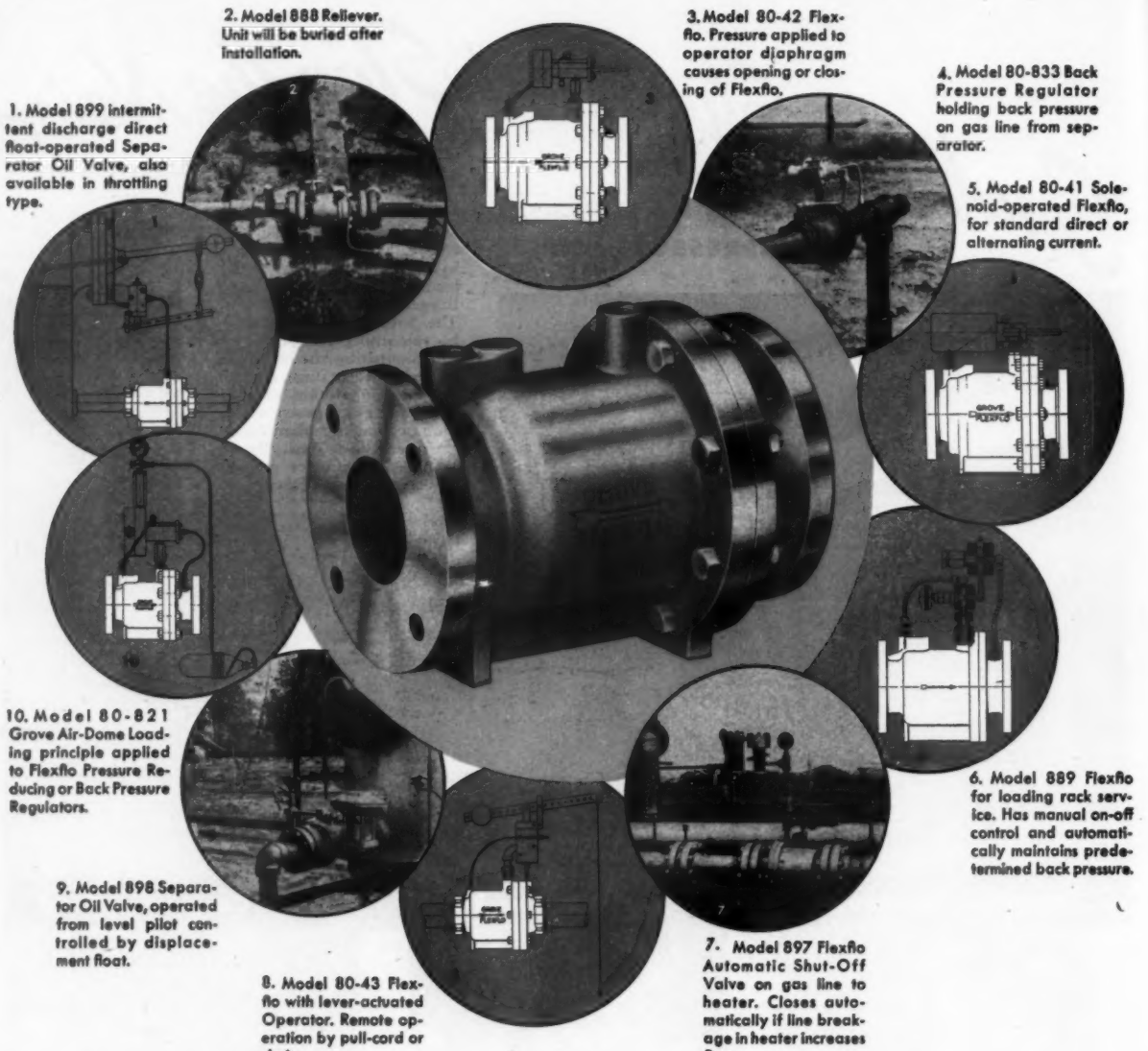

1. Model 899 intermittent discharge direct float-operated Separator Oil Valve, also available in throttling type.

2. Model 888 Reliever. Unit will be buried after installation.

3. Model 80-42 Flexflo. Pressure applied to operator diaphragm causes opening or closing of Flexflo.

4. Model 80-833 Back Pressure Regulator holding back pressure on gas line from separator.

5. Model 80-41 Solenoid-operated Flexflo, for standard direct or alternating current.

6. Model 889 Flexflo for loading rack service. Has manual on-off control and automatically maintains predetermined back pressure.

7. Model 897 Flexflo Automatic Shut-Off Valve on gas line to heater. Closes automatically if line breakage in heater increases flow.

8. Model 80-43 Flexflo with lever-actuated Operator. Remote operation by pull-cord or chain.

9. Model 898 Separator Oil Valve, operated from level pilot controlled by displacement float.

10. Model 80-821 Grove Air-Dome Loading principle applied to Flexflo Pressure Reducing or Back Pressure Regulators.

The Versatile GROVE Flexflo

The heart of each unit shown here is the never-failing Flexflo Valve. Whether your control problem is simple on-off; pressure reduction or relief; holding back-pressure; automatic shut-off; continuous or intermittent separator discharge, or any of a score of other services, the Flexflo is the valve for the job.

This flexibility is achieved through Grove's broad range of Operators. These Operators match and complement the Flexflo's ability to close bubble-tight, to resist corrosion and erosion, and to give the maximum of maintenance-free performance. Contact the nearest Grove office today for full details.

GROVE REGULATOR COMPANY
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GROVE FLEXFLO REMOTE CONTROL VALVE

USER REPORT:

T. E. Mercer Equips Fleet with Warner Electric Brakes. Reports Savings in Maintenance on Brakes and Tires . . . reduced Insurance Rates . . . Improvement in Safety Rating

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TEAMING AND TRUCKING CONTRACTOR
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ADDRESS REPLY TO
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LONGVIEW, TEXAS

Mr. L. H. Hampton
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Dallas, Texas

Dear Sir:

About 2½ years ago we installed the first pair of Warner Electric Brakes on a pipe trailer. Since that time we have equipped all our pipe trailers with your brakes, which means we have approximately 50 pairs in service.

A large portion of the cost of the brakes has been offset by a reduction in insurance rates, savings in maintenance on tractor brakes, and tires. Our drivers are pleased with the performance of electric brakes. You will also be interested to hear that our safety rating has risen considerably.

We thought you would like to know why we are Warner Electric Brake boosters.

Yours very truly,

T. E. MERCER
TEAMING AND TRUCKING CONTRACTOR

By W. O. Chambers

WOC:peb

A NEW user — or an old customer — their opinions about Warner Electric Brake performance, safety, maintenance are always the same. The experience of Mr. Chambers of the T. E. Mercer Company is typical.

Warner Electric Brakes are fast and positive acting. Because they operate *electrically*, they give faster action and braking control not possible with any other kind of brakes. What's more, their mechanical simplicity and rugged construction make them extremely economical to maintain. Many users are still operating Warner Electric Brakes originally purchased 10, 15 and 20 years ago!

Write for illustrated literature explaining their many advantages.

WARNER ELECTRIC BRAKE & CLUTCH CO.
Dept. OGJ, BELOIT, WISCONSIN

WARNER
ELECTRIC BRAKES

SINCE 1927

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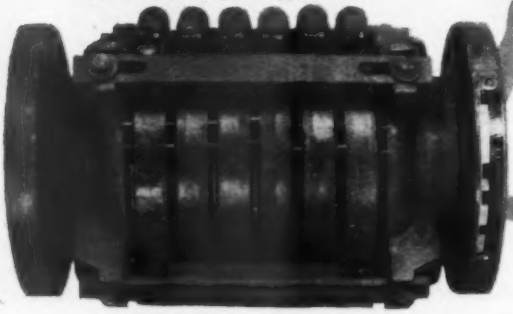
HERE'S WHY

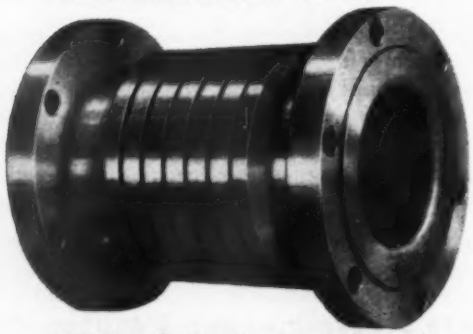
CMH Expansion Joints are preferred by so many piping engineers

- ✓ Space Saving
- ✓ Weight Saving
- ✓ Streamlined Flow
- ✓ Lower Overall Cost
- ✓ Ease of Installation
- ✓ Trouble Free Operation
- ✓ Freedom from Maintenance

CMH Free-Flexing Expansion Joints for pressures to 30 psi; stainless steel or copper; flanges or welding ends; standard sizes to 30" I.D.; larger sizes available for special applications.



CMH Controlled Flexing Expansion Joints for pressures to 300 psi; stainless steel or copper; flanges or welding ends; sizes to 30" I.D.



CMH Flexoniflex Expansion Joints with integral control rings for pressures to 1500 psi; stainless steel and other alloys; standard sizes ⅜" through 6" I.D.; larger sizes also available.

THE PROBLEMS of pipe motion control are reduced to a minimum when you use CMH corrugated type expansion joints. Scientifically formed by advanced methods, they represent the modern, cost-saving, trouble-saving way to control axial, lateral or radial motion in piping or to correct for misalignment.

For new installations or for replacement of obsolete equipment, specify CMH expansion joints. Complete data is given in CMH'S Expansion Joint Design Guide. Write for a copy . . . it's the first step towards eliminating the headaches that are so often a part of pipe-line motion control.

Flexon identifies CMH products that have served industry for over 48 years.

CHICAGO METAL HOSE Corporation

1345 S. Third Avenue • Maywood, Illinois • Plants at Maywood, Elgin and Rock Falls, Ill.
In Canada: Canadian Metal Hose Co., Ltd., Brampton, Ont.

CMH

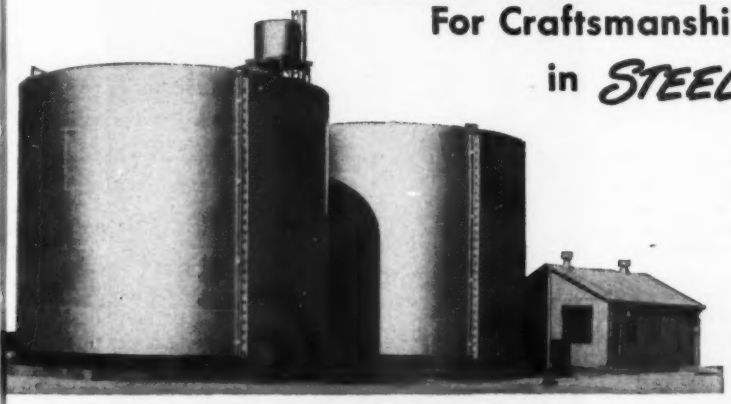
ONE DEPENDABLE SOURCE
for every flexible metal hose requirement

Convoluted and Corrugated Flexible Metal Hose in a Variety of Metals • Expansion Joints for Piping Systems
Stainless Steel and Brass Bellows • Flexible Metal Conduit and Armor • Assemblies of These Components

Specify-

PITTSBURGH•DES MOINES

For Craftsmanship and Satisfaction in *STEEL STORAGE TANKS*



Spheres for storage of volatile liquids under pressure . . . flat-bottomed, cone roof tanks for liquid storage at atmospheric pressure . . . engineered, fabricated and erected to the most exacting standards, employing any required metal or alloy. Use Pittsburgh-Des Moines' experience and special research facilities in determining the storage units best suited to your needs—*write for an early consultation.*

PITTSBURGH • DES MOINES STEEL COMPANY

Plants at PITTSBURGH, DES MOINES and SANTA CLARA

Sales Offices at:

PITTSBURGH (25)	3496 Neville Island	DES MOINES (8)	997 Tuttle Street
NEW YORK (7)	Room 980, 270 Broadway	DALLAS (1)	1201 Praetorian Building
CHICAGO (3)	1202 First National Bank Building	SEATTLE	906 Lane Street
	SANTA CLARA, CAL.	603 Alviso Road	

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ON WELDING NECK TRANSITIONS, **TESCO** CASTINGS PROVIDE

3 Big Advantages

- **IMPROVED FLOW**
- **REDUCED INVENTORY**
- **REDUCED COSTS**

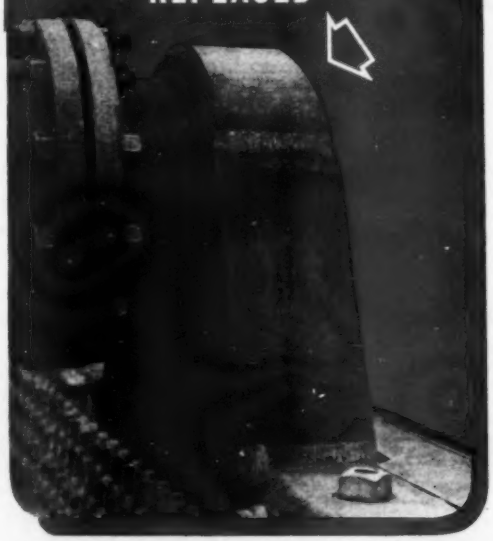
One of the most desirable features in a welding neck transition is a smooth, unrestricted flow from the rectangular opening through the round opening at the flange. Conversion to a Tesco steel casting not only greatly improved flow characteristics but provided these other advantages:

1. A smaller inventory in that one size casting accommodates a number of different size flanges;
2. Cost reductions as high as 60%;
3. Greatly improved appearance.

You may find that conversion of some of your parts to steel castings will result in equal if not greater advantages. Tesco maintains a product engineering department to work with your engineers in the design of new products or in redesigning old products. This service is offered without cost or obligation.

Make an appointment today for the Tesco product engineer to study your designs. We can show you countless case histories of how other manufacturers have used this Tesco service to good advantage. And you will find at Tesco every modern facility in tools and craftsmanship to produce the very highest quality steel castings for every industrial use!

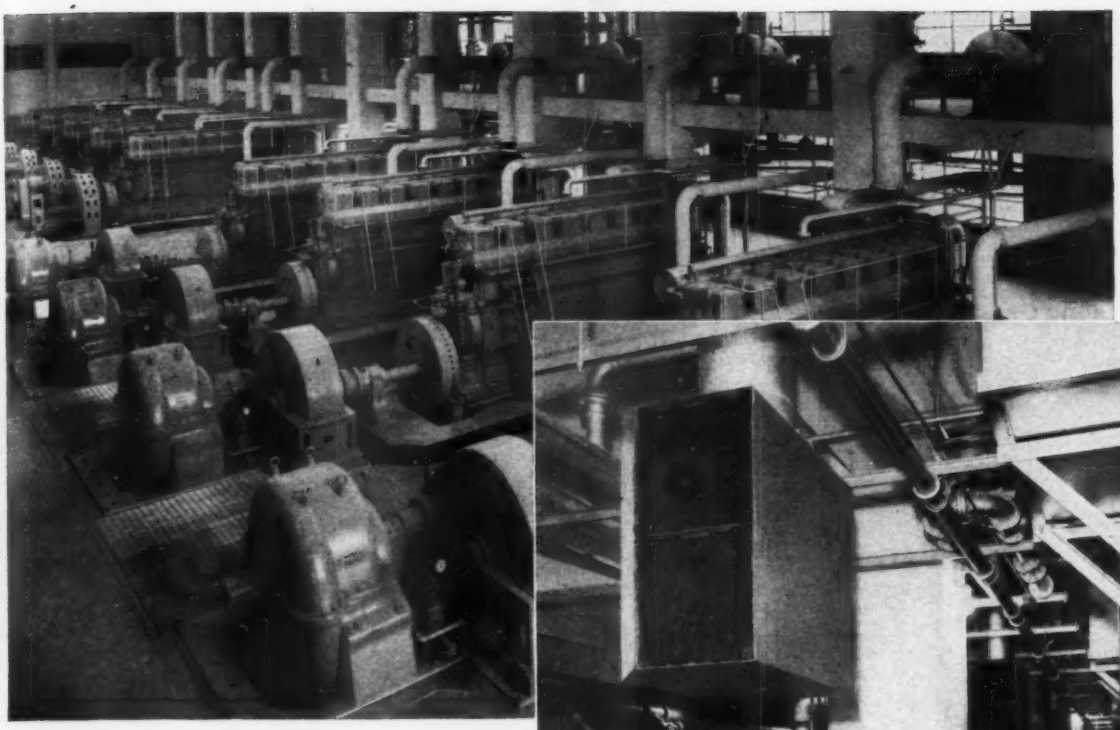
HERE'S THE WELDMENT THE TESCO CASTING REPLACED



TESCO IS THE MOST EXPERIENCED FOUNDRY ON THE GULF COAST

TEXAS ELECTRIC STEEL CASTING CO.

GOOD CASTINGS — CARBON AND ALLOY STEEL — HOUSTON, TEXAS



the air intakes of these nine engines have **AAF FILTER PROTECTION** at Hyperion Sewage Disposal Plant

THE HYPERION SEWAGE DISPOSAL PLANT in Los Angeles is one of the finest systems of its kind in the world. No expense has been spared in the facilities or equipment—AAF Electro-Matic Self-Cleaning Electronic Precipitators were used to provide super-clean air for the activated sludge process—AAF Type OCH Filters were selected to clean the intake air for the nine big engines that serve the power needs of this plant.

Type OCH is one of several types of AAF filters designed for cleaning the intake air for engines and compressors. At Hyperion they clean inside air which has already been cleaned by the ventilating filters—proof of AAF's high efficiency in removing dust and dirt from the air.

Any expensive engine needs the kind of protection AAF can deliver. And if you have a special problem, just call on AAF's engineers. Their experience has benefited thousands.

WRITE TODAY for complete information on the different types of AAF filters for engines you build, own or operate.

Today's Best Buy is Better Air!

AAF

American Air Filter

COMPANY, INC.

444 Central Avenue, Louisville 8, Kentucky • In Canada: Darling Bros., Ltd., Montreal, P. Q.

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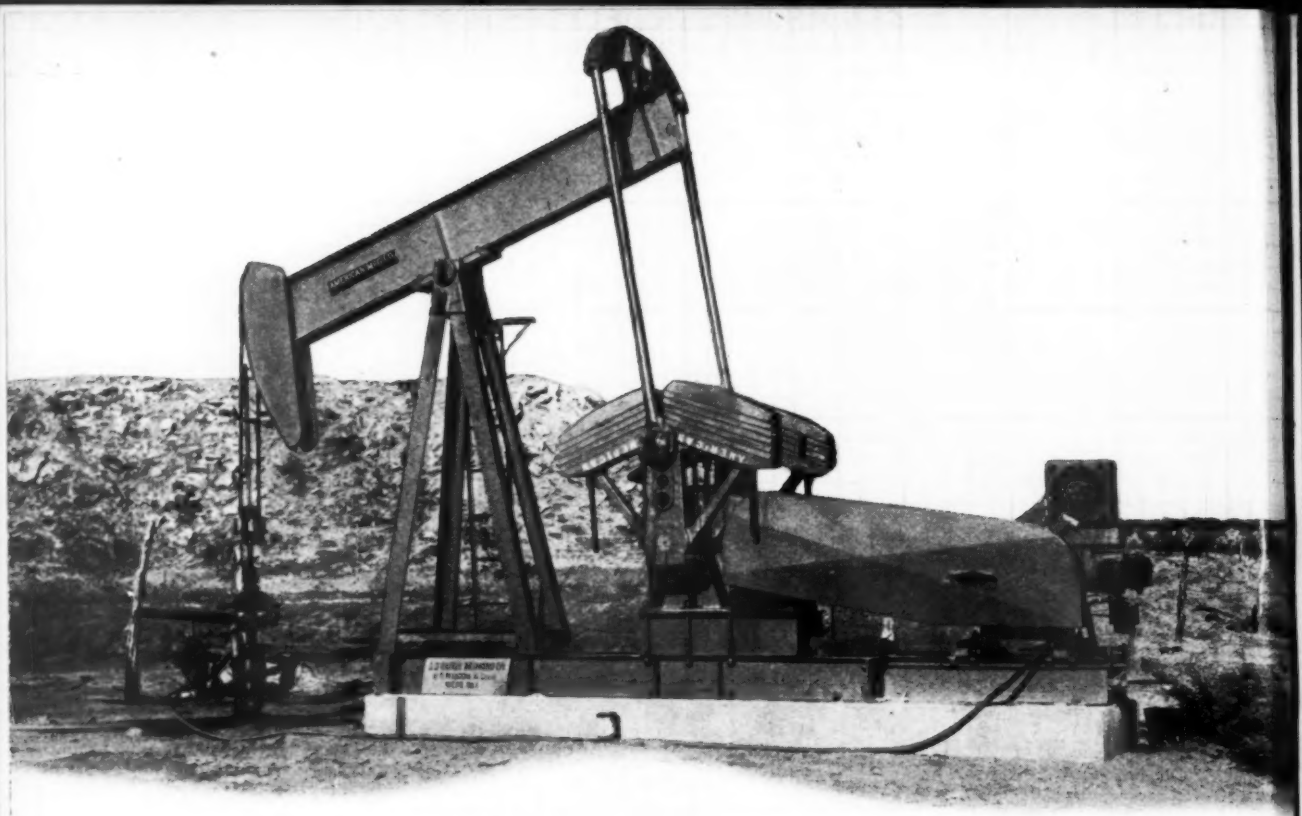


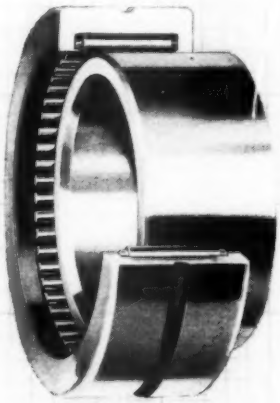
pump saddles ride easier...

WITH TORRINGTON BEARINGS

Saddle and equalizer friction and wear are minimized in pumping units of American Manufacturing Company of Texas by the use of Torrington heavy-duty NCS Needle Bearings.

For one thing, there are many cavities between small diameter rollers for retaining lubricant at all bearing surfaces. The full complement of rollers also provides maximum load capacity in minimum space for long, trouble-free service.

Where high load capacity, efficient anti-friction operation and compact design may benefit your product, consult Torrington's engineers on the application of Torrington Type NCS Needle Bearings.



THE TORRINGTON COMPANY

South Bend 21, Ind. • Torrington, Conn.

District Offices and Distributors in Principal Cities of United States and Canada

TORRINGTON BEARINGS

SPHERICAL ROLLER • TAPERED ROLLER • STRAIGHT ROLLER • NEEDLE • BALL • NEEDLE ROLLERS

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For BETTER, EASIER housekeeping

with Maximum Safety

THESE FLOORS ARE KEPT CLEAN AND SAFE BY THE MULTI-CLEAN METHOD

A noticeable characteristic of plants like the above is the immaculately kept floors and all around good housekeeping. These beautiful floors are typical examples of what the Multi-Clean Method is accomplishing in plants of the Petroleum Industry all over the country. Their luxurious finish, obtained through application of Multi-Clean approved floor liquids, is non-slip, making floors safe to walk on and work upon. This finer floor care improves working conditions, stimulates employe morale and is a distinct public relations asset.

The use of the Multi-Clean Explosion Proof Floor Machine is providing mechanical floor maintenance in many plants without the danger of fire and explosion. It is used with absolute safety for buffing, cleaning and polishing all floors, whether concrete, terrazzo, asphalt tile, rubber tile, wood or linoleum.

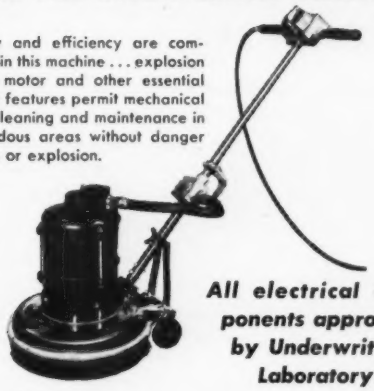
MULTI-CLEAN®
PRODUCTS, INC.

2277 Ford Parkway St. Paul 1, Minn.

MULTI-CLEAN®
PRODUCTS, INC.

EXPLOSION PROOF FLOOR MACHINE and THE MULTI-CLEAN METHOD

Safety and efficiency are combined in this machine . . . explosion proof motor and other essential safety features permit mechanical floor cleaning and maintenance in hazardous areas without danger of fire or explosion.



All electrical components approved by Underwriters Laboratory.

SAVES TIME AND LABOR ASSURES UTMOST SAFETY

The Multi-Clean Explosion Proof Floor Machine gets better results faster . . . more safely. Man hours required are reduced over slow and expensive hand labor by cleaning with the one-man machine method. Floors are made safer by the thorough cleaning action which removes all accumulations of grease, chemicals, or other dangerous materials. And the Multi-Clean Method beautifies floors, makes them longer-lasting, protects them against wear and corrosion.

***Mail* COUPON TODAY!**

Multi-Clean Products Inc.
2277 Ford Parkway, Dept. 33B, St. Paul 1, Minnesota

Gentlemen: Please send me further information on the Multi-Clean Explosion Proof Floor Machine and the Multi-Clean Method.

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ADDRESS_____

CITY_____ ZONE____ STATE_____

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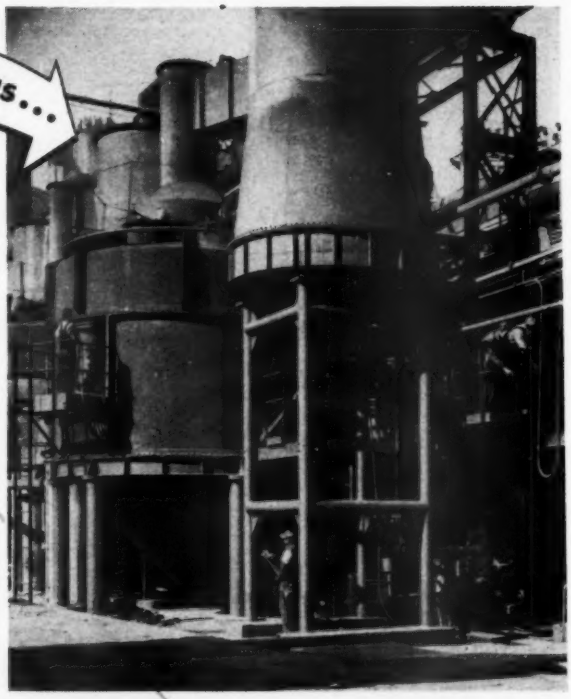
In the field of protective coatings...

QUALITY MEANS
INSUL-MASTIC

Coatings carefully manufactured to do a job, *not by-products,* or *hasty formulations to tap a market.* Quality coatings are Insul-Mastic's *only* business and *they have no equal.*



LONG LIFE

Insul-Mastic's maintenance-free life was determined to be approximately 50 years by a well known testing laboratory*. An eight-year continuous test in a Weather-O-Meter (equivalent to 57 years outside weather) has corroborated this finding. Gilsonite plus carefully chosen and tested Mica Flake, make possible this quality. U.S. Bureau of Standards determined such mica by far the most effective filler contributing to long life.

RESISTANCE TO EXTREME TEMPERATURES

Insul-Mastic has a temperature range of −40° F. to +300° F. due to proper balancing of high melting point Gilsonite and low melting point asphalts.

RESISTANT TO MOST ACIDS AND ALKALIS

Insul-Mastic's principal ingredient is Gilsonite, a hydrocarbon so thoroughly saturated that it is practically inert and, therefore, rarely displaced by acids and alkalis.

EASY TO SPRAY

Homogenized and filtered Insul-Mastic flows smoothly through the spray gun and onto the surface without blobs and pinholes or clogging the gun.

NO HARMFUL EFFECTS... ODORLESS AFTER DRYING

Insul-Mastic has no toxic fumes which necessitate wearing a mask, nor will it burn the eyes or skin of workmen. These coatings have no odor after they have dried.

Think first of the coatings that last!

For the prevention of corrosion; for a sprayable, moisture resistant insulation; for vaporsealing soft thermal insulation; for sealing buildings against moisture—*write for the name of your nearest Insul-Mastic licensee.*

*Name on request

Insul-Mastic Corporation
OF AMERICA
1158 OLIVER BUILDING · PITTSBURGH 22, PA.
Representatives in Principal Cities

INSUL-MASTIC
INSUL-MASTIC COATINGS
CORROSION PROOFING
WATERPROOFING
VAPOR SEALING
INSULATION

Want your tubes to last longer, cost less—or both? Ask the experts!

This month Timken reports on: **18-8 STAINLESS**

An austenitic, non-magnetic alloy that shows the best combination of creep strength, oil corrosion resistance and oxidation resistance for service up to 1500° F. For use in oil cracking systems, hydrogenation equipment, high temperature oil and steam piping, superheater elements, heat exchangers.

ONE OF 23 TIMKEN HIGH TEMPERATURE STEELS

Carbon	Sicromo 2	Sicromo 5S	16-13-3*
Carbon-Mo.	Sicromo 2½	Sicromo 5MS	25-20*
DM-2	2½% Cr.-1% Mo.	Sicromo 7	25-12*
Silmo	Sicromo 3	Sicromo 9M	35-15*
DM	4-6% Cr.-Mo.	18-8 Stainless	16-25-6*
2% Cr.-Mo.	4-6% Cr.-Mo.-Ti.	18-8 Cb	

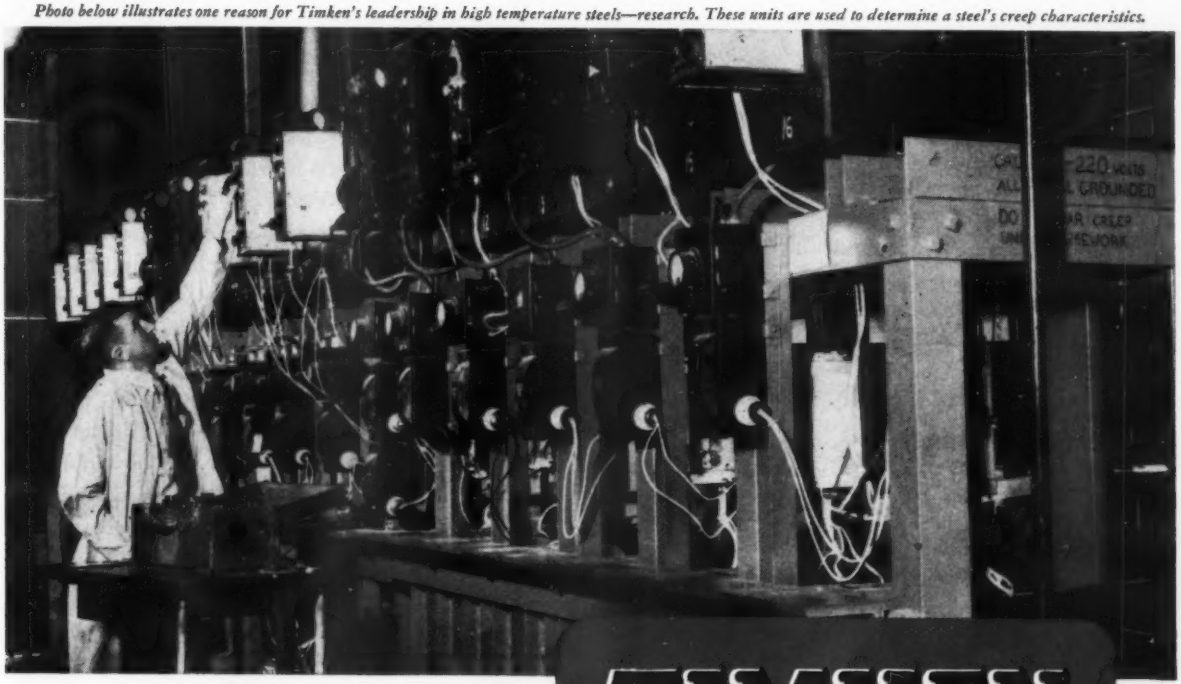
**Available as seamless tubing on an experimental basis only.*

ONLY *one* high temperature tube steel can give you the best life/cost ratio. It's the steel that's tailor-made for your particular operating conditions.

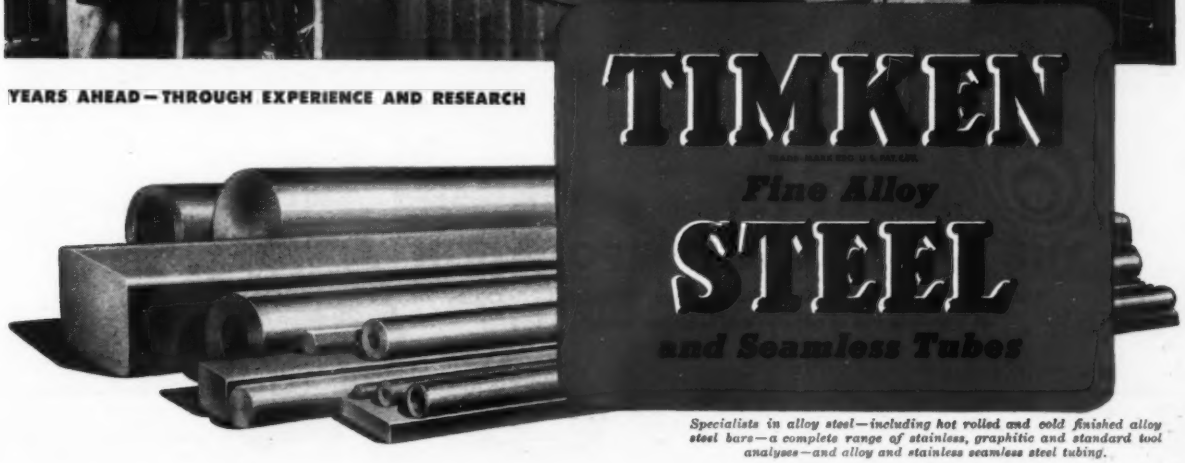
To make sure you select the *right* steel, get the help of the acknowledged experts in this field—metallurgists of The Timken Roller Bearing Company. They're backed by more than 20 years of outstanding research. By the widest field experience. By a range of 23 high temperature steels. By *uniform* tube quality—assured under Timken's complete, rigid control from melt shop through final inspection.

Let Timken's "RSQ"—Research, Supply, Quality—solve *your* tube problems. Ask the experts! The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio.

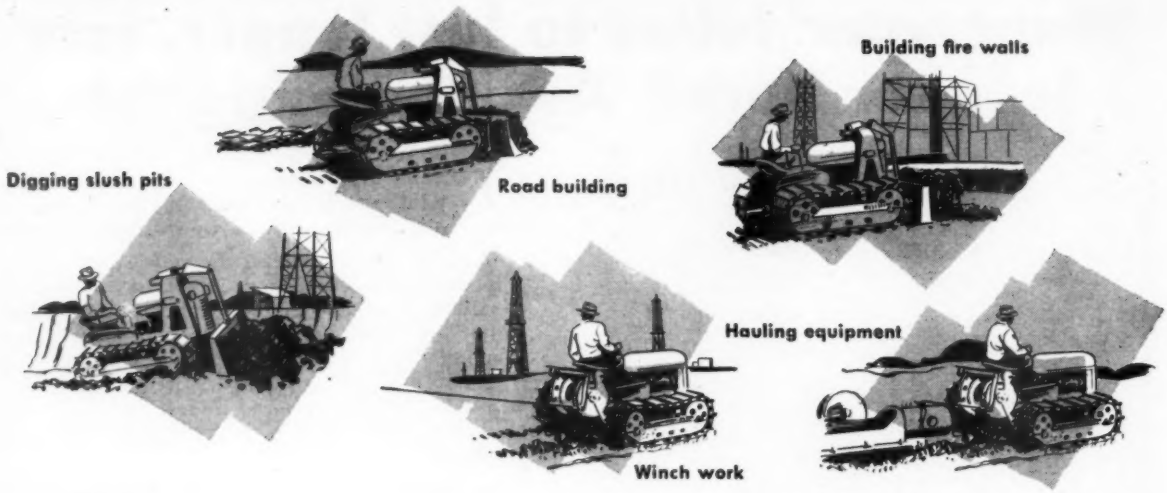
Photo below illustrates one reason for Timken's leadership in high temperature steels—research. These units are used to determine a steel's creep characteristics.



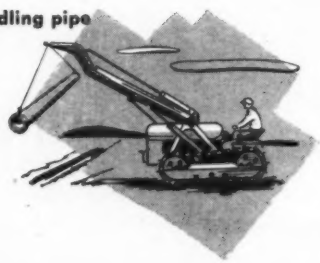
YEARS AHEAD—THROUGH EXPERIENCE AND RESEARCH



Specialists in alloy steel—including hot rolled and cold finished alloy steel bars—a complete range of stainless, graphitic and standard tool analyses—and alloy and stainless seamless steel tubing.



Where can You use this Tractor?



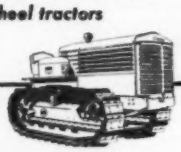
● We'll be frank and say we don't know of *all* the uses around field and refinery where this powerful little tractor can help your operations We do know of many operations the Oliver HG . . . the smallest crawler tractor on the market . . . is performing today. But, it seems that every day someone comes up with a new use. So we'll just say that wherever you need a small but powerful prime mover . . . where low operating and maintenance costs are important, you can use the Oliver HG in your operations.

The illustrations will give you a rough idea of the versatility and usefulness of this handy little tractor and its line of accessory equipment. For information, write The Oliver Corporation, 19300 Euclid Avenue, Cleveland 17, Ohio.

THE OLIVER CORPORATION

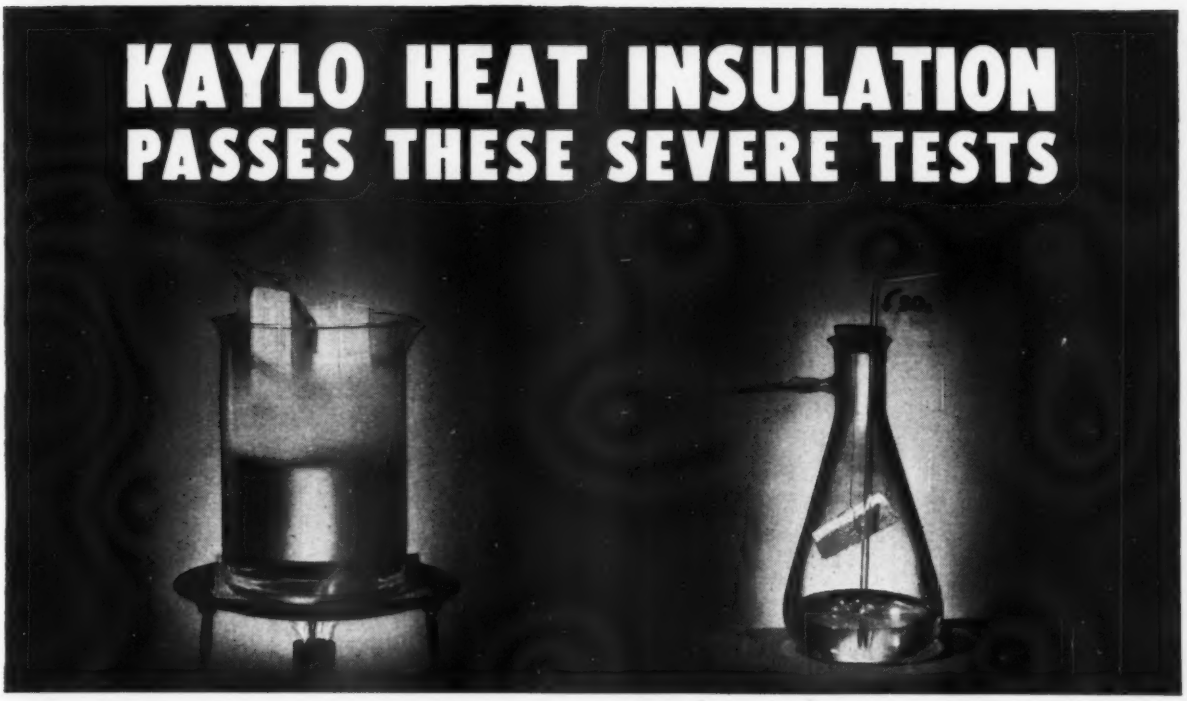
Industrial Division: 19300 Euclid Avenue, Cleveland 17, Ohio

A complete line of crawler and industrial wheel tractors



THE OLIVER CORPORATION

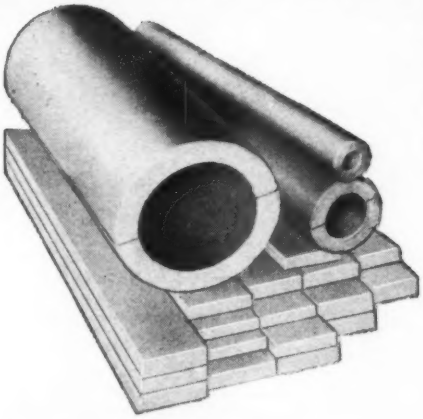
KAYLO HEAT INSULATION PASSES THESE SEVERE TESTS



BOILING TEST: Samples of Kaylo Heat Insulation have been boiled continuously for 24 hours and longer. None disintegrated or showed any loss of insulating efficiency after drying.

FUME TEST: Samples of Kaylo Heat Insulation were suspended in an aerated mixture of water vapor and SO_2. The Kaylo samples showed no deterioration after weeks of direct exposure.

One Material Insulates Efficiently up to 1200°F.



Kaylo Heat Insulation is made of hydrous calcium silicate (not glass), a remarkable material with high insulating efficiency up to 1200°F. This new type of inorganic insulating material retains its stability in long service under severe conditions. Exceptional strength and lighter weight make it easier to handle and apply.

KAYLO PIPE INSULATION is produced in Simplified Dimensional Standards of thicknesses and diameters for pipe sizes from ½" to 72". Coverings are sectional for sizes ½" to 12"; tri-segmental for 8" to 23"; quad-segmental for 19" to 41"; K-segmental (18" sections) for 38" to 72". O.D.'s of insulation correspond to O.D.'s of standard pipes.

KAYLO HEAT INSULATING BLOCK is available for single layer application in thicknesses from 1" to 6". It is made in all standard sizes up to 18" x 36".

KAYLO®

PIPE INSULATION AND HEAT INSULATING BLOCK

OWENS-ILLINOIS GLASS COMPANY
Kaylo Division • Toledo 1, Ohio

SALES OFFICES:
Atlanta · Boston · Buffalo · Chicago · Cincinnati · Houston · Minneapolis · New York
Oklahoma City · Philadelphia · Pittsburgh · St. Louis · Toledo · Washington

SEND COUPON FOR KAYLO HEAT INSULATION LITERATURE

OWENS-ILLINOIS GLASS COMPANY
Dept. N-85, Kaylo Division • Toledo 1, Ohio

Gentlemen: Please send me descriptive literature on Kaylo Heat Insulation.

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FIRM.....

ADDRESS.....

CITY.....STATE.....

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COLUMBIAN

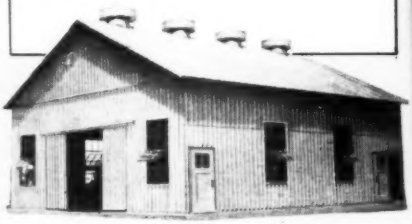
BOLTED STEEL TANKS

FIRST with API Tanks of Every Size!

Years ago when the American Petroleum Institute decided on standard specifications for API tanks, Columbian immediately developed API tanks in every size. Today, Columbian continues this leadership in storage tank design and fabrication . . . and remains FIRST in the minds of oil producers all over the world. Because exclusive construction features, easy assembly and long-life service mean extra economy and extra value in every Columbian Tank. Write for complete information.

COLUMBIAN STEEL TANK CO. P. O. Box 4226-H KANSAS CITY, MO.

**Columbian All-Metal Buildings* are ideal for warehouses, engine houses, garages, equipment and storage houses. Rigid, strong, fire-safe, low upkeep.



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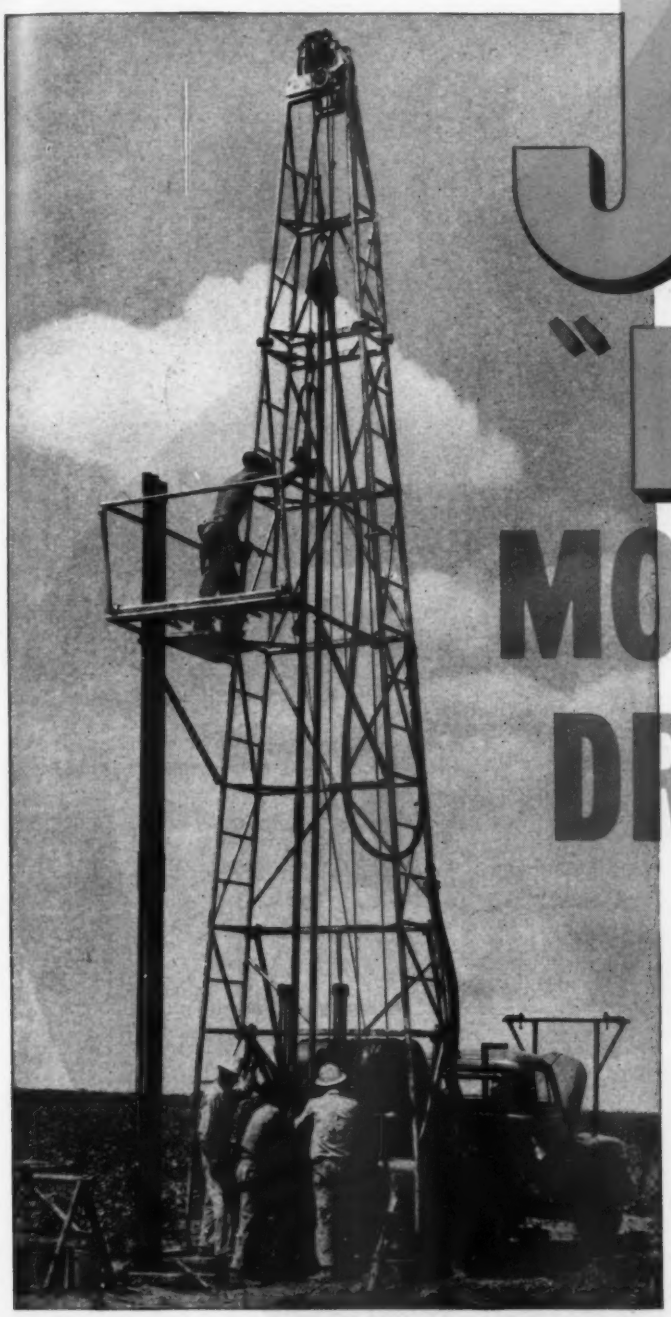
Light! Highly Mobile! Fast-Drilling!



JOY "150" MOTORIZED DRILL RIG

For medium-depth structure testing, core or water-well drilling, etc., the JOY 150 tops the field. Unitized design, easily adjusted or repaired. Incorporates such desirable features as oil-bath lubricated chain drives, retractable rotary table for handling casing, reversible rotary mechanism, built-in PTO drive, automatic chuck, etc. Available with single or double-drum hoist, and with or without hydraulic feed, to give you maximum hole footage per day in its class! ● Complete line of Drill Rigs to 5000 feet.

WRITE FOR BULLETIN OR

Consult a Joy Engineer

W&D O 3000

JOY MANUFACTURING COMPANY

GENERAL OFFICES: HENRY W. OLIVER BUILDING · PITTSBURGH 22, PA.

IN CANADA: JOY MANUFACTURING COMPANY (CANADA) LIMITED, GALT, ONTARIO

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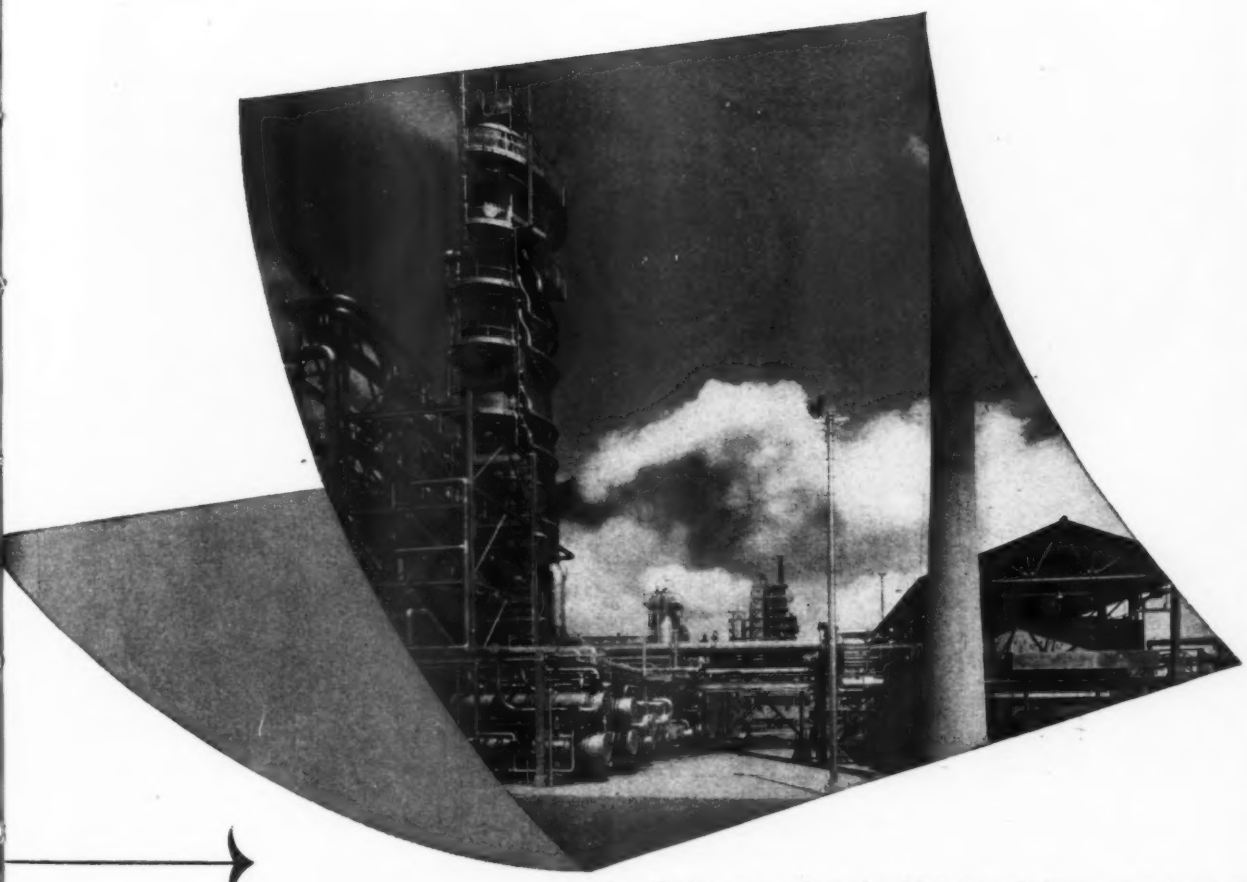
NEW LUBE OIL PLANT FOR SOHIO

designed and built by LUMMUS



In mid-July a new and complete lubricating oil plant went on stream at SOHIO's large Lima refinery. Lummus designed and built four of the five processing units which will produce approximately 1800 barrels per day of high grade lubricating oils.

Lummus applied new and improved techniques in the design of SOHIO's lube-oil plant. A new fluidized method of clay handling is employed in the contact units. A hot oil-belt system provides all the heat required for the FURFURAL, MEK, and CLAY-CONTACT Units. A single console instrument panel is used to control the operation of the FURFURAL and MEK Units.

The Lima plant reflects the leading role Lummus has played in the building of outstanding lube-oil refineries. Lummus has designed and constructed over 115 lubricating oil processing units. To a study of your individual problems, whether solvent refining, the modernization and expansion of existing units, or new projects, Lummus can add the experience gained through years of designing and building petroleum, petroleum chemical and chemical plants.

PETROLEUM HORIZONS, the new 80-page book on Lummus processes and plants, features a step-by-step description and flow sheets for 31 refinery processes. Your copy available on request.

THE LUMMUS COMPANY

designing engineers and constructors for the petroleum and chemical industries

385 Madison Avenue · New York 17, N. Y.

CHICAGO · HOUSTON · LONDON · CARACAS · PARIS

XUM

This Simple Compressor Meets the Complex Needs of a Changing Petroleum Industry

It's the Nash!

Here is a compressor presenting advantages found in no other device. Nash Compressors have only one moving part, rotating without metallic contact with the pump casing. No internal lubrication is required. Yet they produce 75 lbs. pressure in a single stage, with capacities to 6 million cu. ft. per day in a single structure.

There are no valves, gears, pistons, sliding vanes, or other complicated wearing parts in a Nash. Compression is secured by an entirely different principle of operation. Because of this, gas pumping problems difficult with ordinary pumps are often easily handled by the Nash. For example, Nash Pumps are standard equipment in the Synthetic Rubber Industry, where they have met the needs of new and difficult processes.

Nash Compressors are compact and save space. They run without vibration, and compression is without pulsation. They maintain original performance over long periods. Service is assured by a nationwide net-work of Engineering Service offices. Instructive bulletin shows how they operate. Write for it.

- One moving part.
- No internal wearing parts.
- No valves, pistons, or sliding vanes.
- No internal lubrication.
- Low maintenance.
- Slugs of liquid entering pump do no harm.
- Non-pulsating pressure.
- Saves floor space.
- 75 pounds in a single stage.

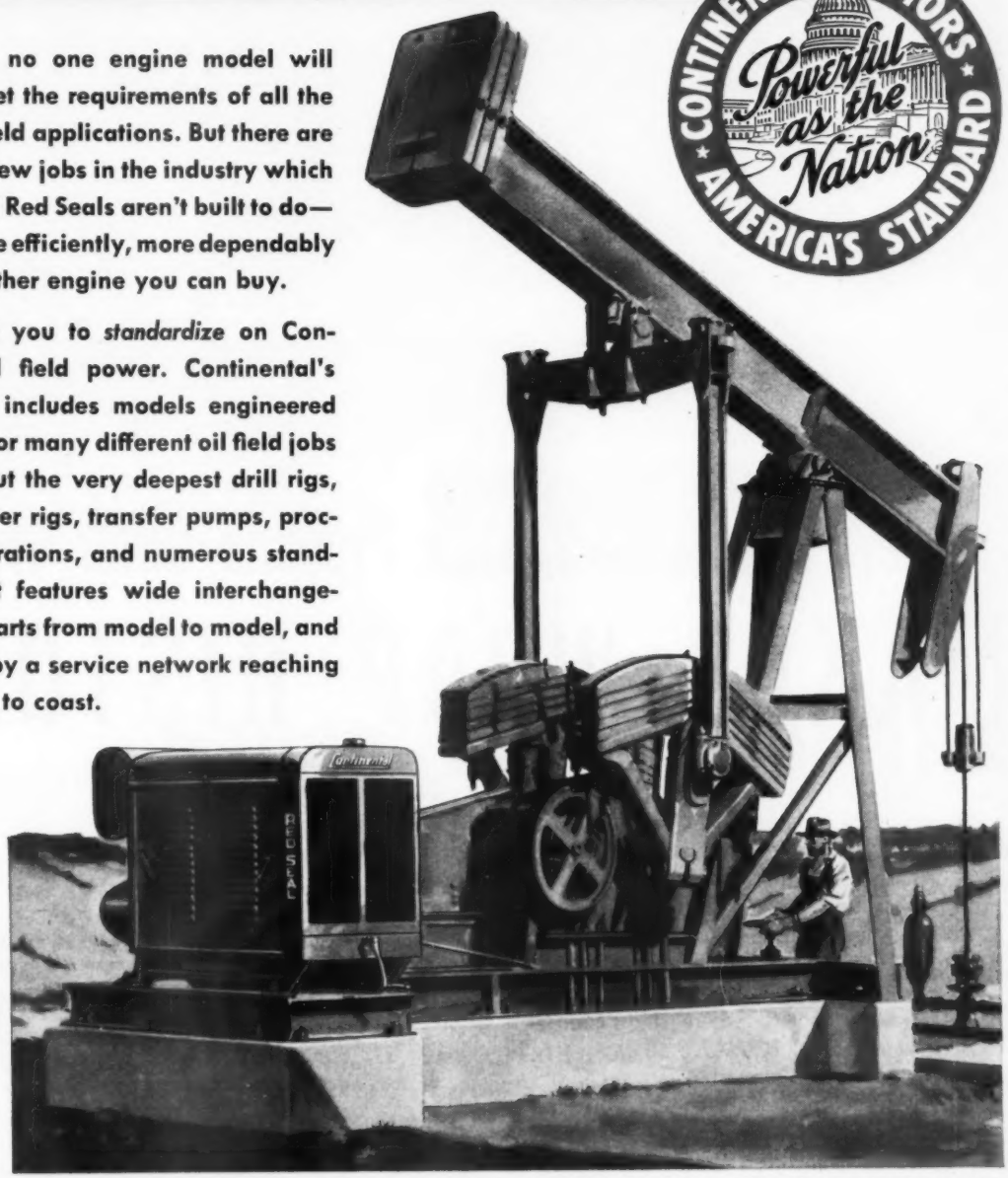
NASH ENGINEERING COMPANY
273 WILSON, SO. NORWALK, CONN.

JUST NAME YOUR JOB...
there's a CONTINENTAL RED SEAL
BUILT TO DO IT RIGHT

CONTINENTAL MOTORS ★ *Powerful as the Nation* ★ AMERICA'S STANDARD

Obviously, no one engine model will exactly meet the requirements of all the many oil field applications. But there are extremely few jobs in the industry which Continental Red Seals aren't built to do—and do more efficiently, more dependably than any other engine you can buy.

It will pay you to *standardize* on Continental oil field power. Continental's broad line includes models engineered expressly for many different oil field jobs—for all but the very deepest drill rigs, for workover rigs, transfer pumps, processing operations, and numerous standby uses. It features wide interchangeability of parts from model to model, and is backed by a service network reaching from coast to coast.

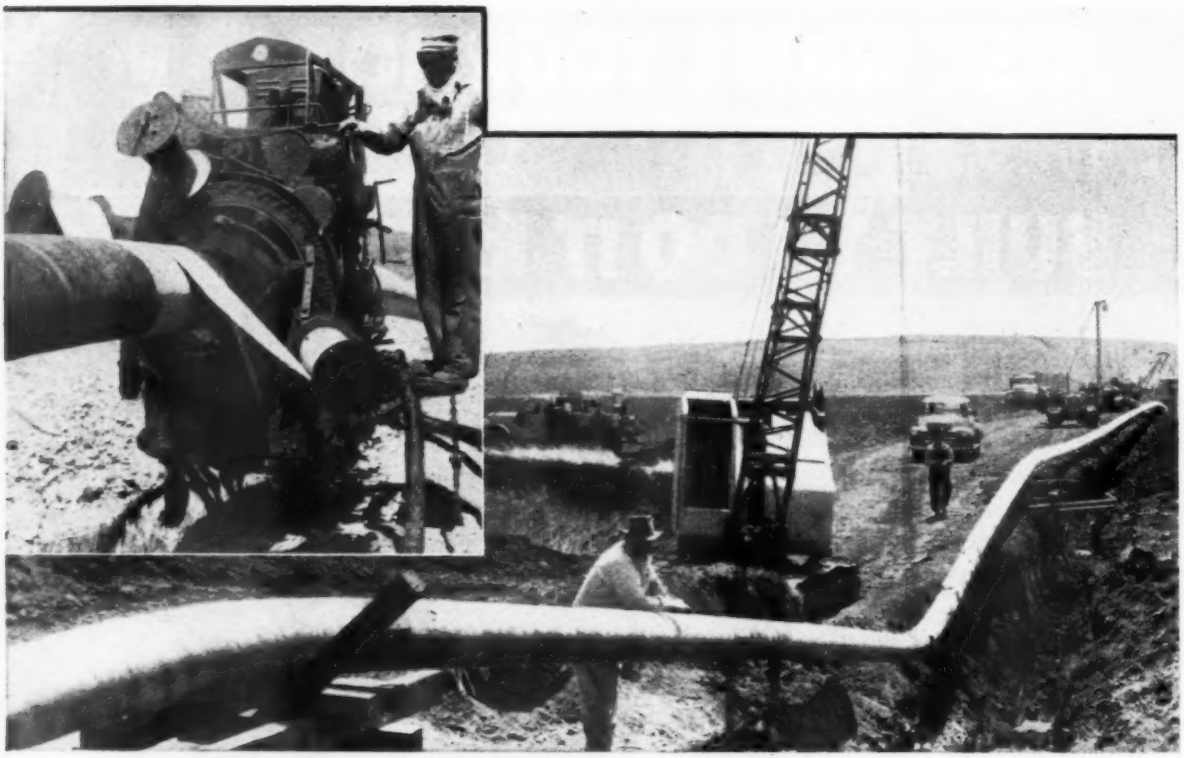


SEE OUR CATALOG IN THE COMPOSITE CATALOG

6218 CEDAR SPRINGS ROAD, DALLAS 9, TEXAS • • • 3817 S. SANTA FE AVE., LOS ANGELES 58, CALIF.

Continental Motors Corporation
MUSKEGON, MICHIGAN

XUM



OWENS-CORNING

New FIBERGLAS Pipeline Outer Wrap

MAKES WRAP HISTORY!

Compare this record with anything in your pipe wrapping experience:

There's a varied terrain at Des Moines, Iowa, and there the new Fiberglas Outer Wrap was tried by its first user, a products pipeline company. Beginning with the first day, here's what happened:

11,000 feet per day where they had been getting 8,000 with the wrap formerly used . . . *Three holidays per mile* where they had been getting dozens . . . *NO BREAKS* all day where previously they had been numerous.

Why wrap the hard way? If you can't equal that record with the material you're using, start *NOW* on Fiberglas Outer Wrap—The product of experience! . . . Owens-Corning Fiberglas Corporation, Dept. 54-K3, Toledo 1, Ohio.

The wrapping record described here was made over streams and hills and around bends at a products pipeline company at Des Moines, Iowa. Both the new Fiberglas* Parallel Reinforced Coromat and the new Fiberglas Outer Wrap were used. *The record applies to both materials.* ***THEY'RE BETTER NATURALLY!***

*Fiberglas and Coromats are trade-marks (Reg. U. S. Pat. Off.) of Owens-Corning Fiberglas Corp.

on Your Pipeline

FIBERGLAS IS ~~IN YOUR LINE~~ . . . FOR GOOD!

new OWENS-CORNING FIBERGLAS PARALLEL REINFORCED COROMAT

Ever see a better-looking wrap job? The records described here were made by a products pipe line company at Des Moines, Iowa. Here both the new Fiberglas* Parallel Reinforced Coromat and new Fiberglas Outer Wrap were used. *The records apply to both materials.* ***They're Better NATURALLY!***

hangs up 3 terrific records

We like to boast about Owens-Corning Fiberglas alertness, and about the Fiberglas Technical and Manufacturing Facilities. But the real test is out in the field. And that's where the new Fiberglas COROMAT and the new Outer Wrap have proved to be the all-time champs among pipe wraps.

LOOK at this experience of a products pipe line company: *11,000 feet a day* against 8,000 with the product used before. That's one record. *Three holidays per mile* against dozens formerly. That's another. *NO BREAKS all day,* against numerous breaks previously. That's number 3.

Want anything more? Better get started now on the sweetest wrapping you ever knew! . . . Owens-Corning Fiberglas Corporation, Department 54-K3, Toledo, 1, Ohio.

*Fiberglas and Coromats are trade-marks (Reg. U.S. Pat. Off.) of Owens-Corning Fiberglas Corp.

on Your Pipeline

FIBERGLAS IS ~~IN YOUR LIFE~~ ...FOR GOOD!

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Everything for your Rig

at your nearby

UNITED SUPPLY STORE

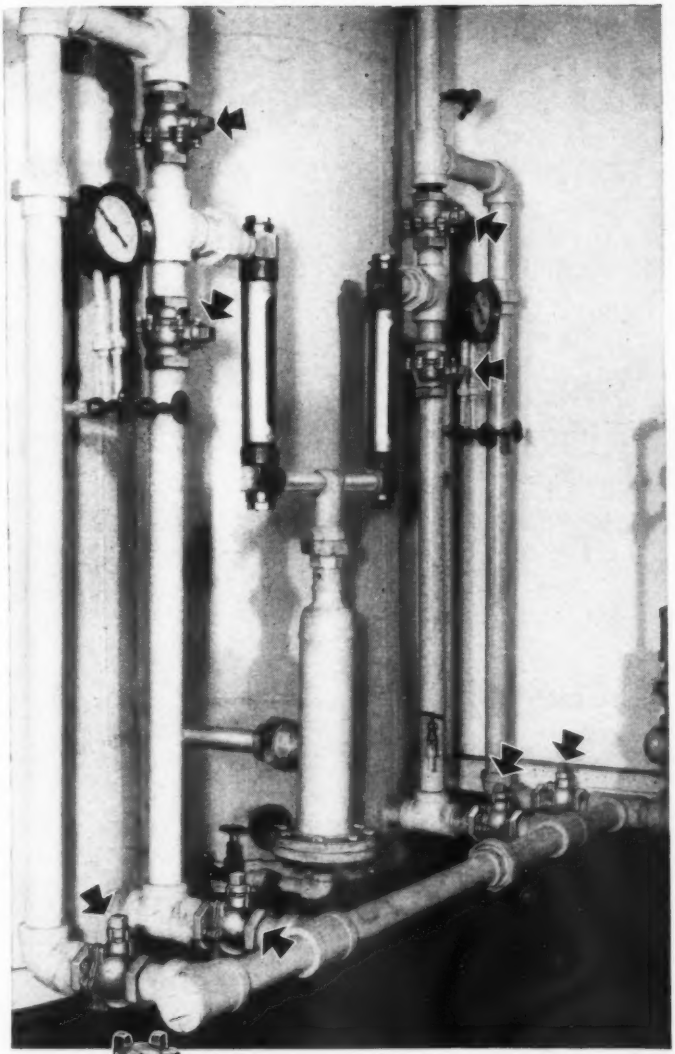
Uncle Sandy SAYS

Courtesy
Service
Dependability

AND *Manufacturing* COMPANY

TULSA, OKLAHOMA

Stores in Kansas, Oklahoma, Texas,
Louisiana, and New Mexico



REDUCE

maintenance cost with

ROCKWOOD

BALL TYPE

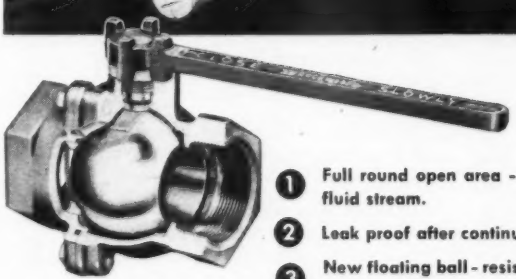
VALVES

Longer service life with no maintenance is a primary advantage of the Rockwood Ball Type Valve that pays off in dollars and cents year in and year out.

The maintenance engineer of this large gas company was quickly convinced that his choice of Rockwood Valves for gasoline lines on "sweetening towers" had been sound. Says this engineer, "The full *round* flow, leak proof service, easy operation and no maintenance cost make Rockwood Valves far ahead of any competitive valve we used."

Rockwood Valves are today giving excellent performance on difficult operations in oil refineries, food, paper, chemical and rubber plants, etc. It will pay you to specify and buy Rockwood Valves. Send for bulletin V-4. Distributors in all principal cities.

Rockwood Valves are recommended for 300 p.s.i. working pressure. Made in bronze with screwed ends in all pipe sizes from ½" to 2".



... YOU'LL PROFIT EVERY DAY WITH THESE FEATURES!

1. Full round open area - no turbulence in fluid stream.
2. Leak proof after continued use.
3. New floating ball - resists pitting, scratching and abrasion.
4. No exposed seating surface in open or closed position.
5. Easy to open or close under full pressure.
6. Installed in any position.
7. Quarter turn (90°) opening and closing valve.

ROCKWOOD SPRINKLER CO

104 HARLOW STREET WORCESTER 5, MASS

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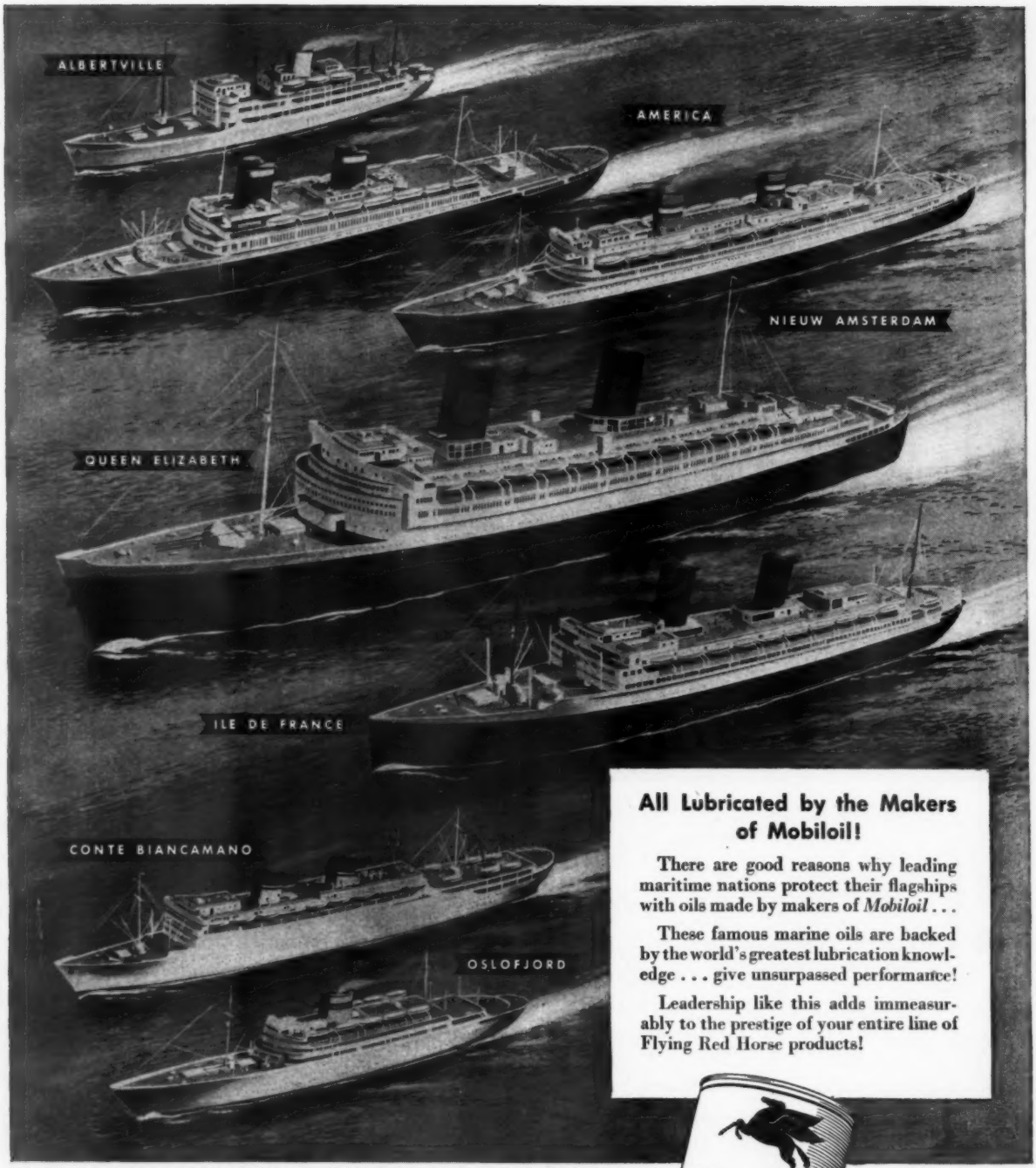
First With the Flagships



All Lubricated by the Makers of Mobiloil!

There are good reasons why leading maritime nations protect their flagships with oils made by makers of *Mobiloil* . . .

These famous marine oils are backed by the world's greatest lubrication knowledge . . . give unsurpassed performance!

Leadership like this adds immeasurably to the prestige of your entire line of Flying Red Horse products!

Now More than Ever—it Pays to Sell the World's Best Seller!

Mobiloil

SOCONY-VACUUM OIL CO., INC., and Affiliates: MAGNOLIA PETROLEUM CO., GENERAL PETROLEUM CORP.

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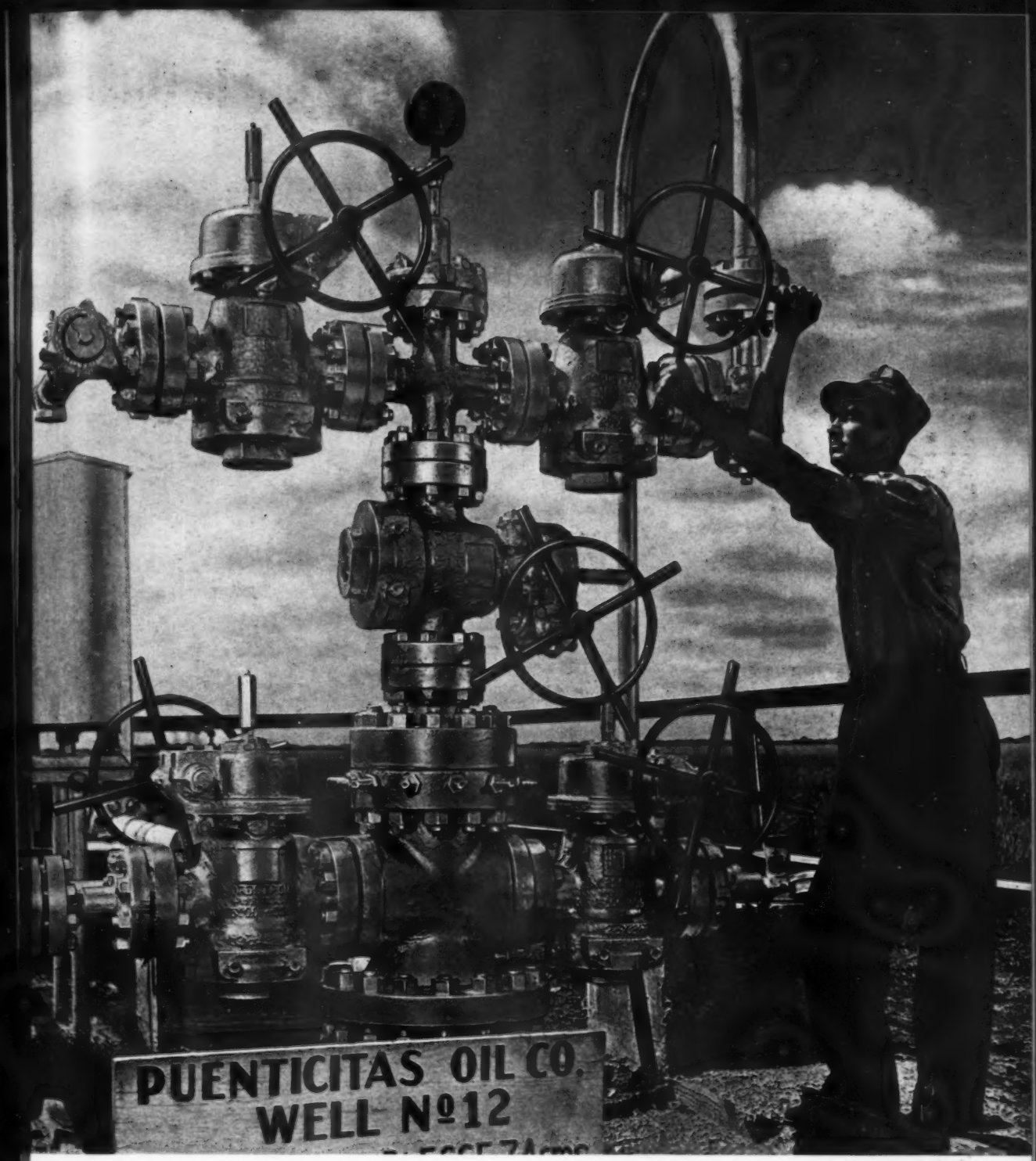

It's a pleasure to operate a Nordstrom valve. Smooth rotary movement instead of dragging action across seat rings insures easiest operation. An entire battery of Nordstroms can be opened or closed within a few minutes, in contrast to hours for some other types. There's no tug or toil to tighten or "break open" a Nordstrom, because the rotary, tapered plug is seated on lubricant, sealed by lubricant and jacked by lubricant.

Nordstrom

AUTOMATICALLY LUBRICATED VALVES

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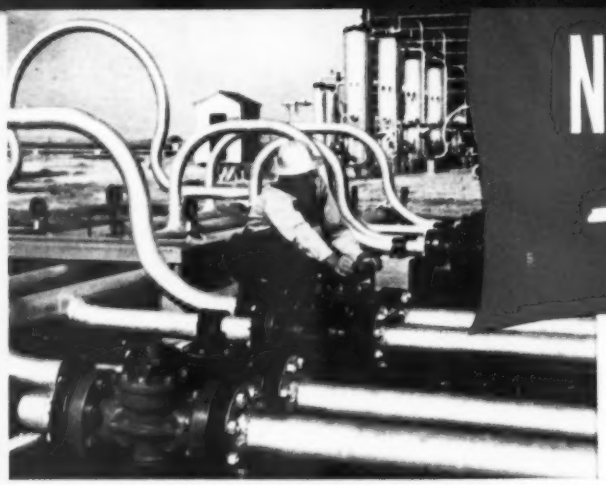
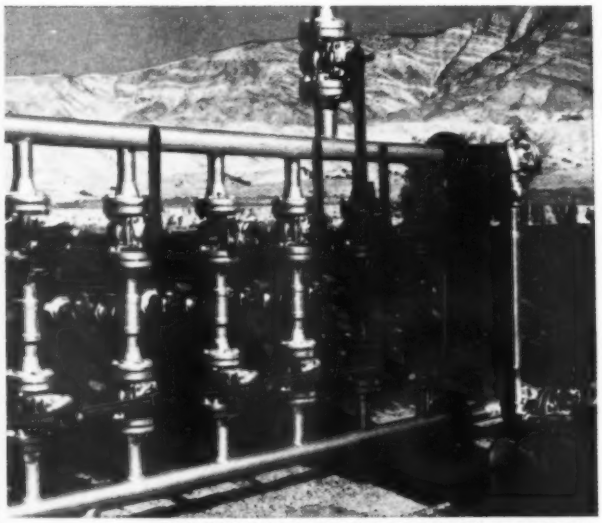
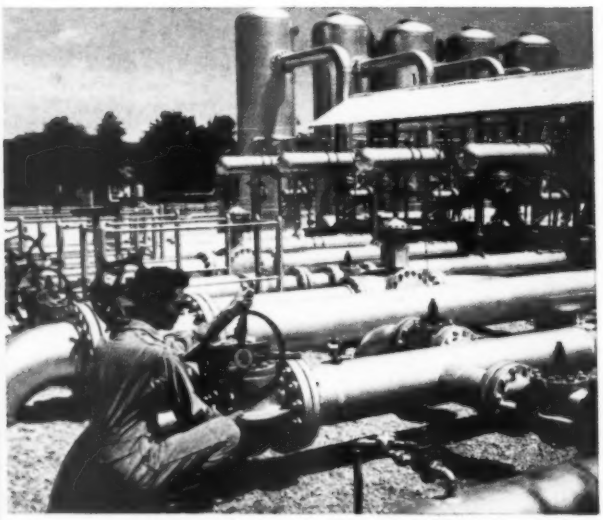
Nordstroms fit the Need —*Unsurpassed*



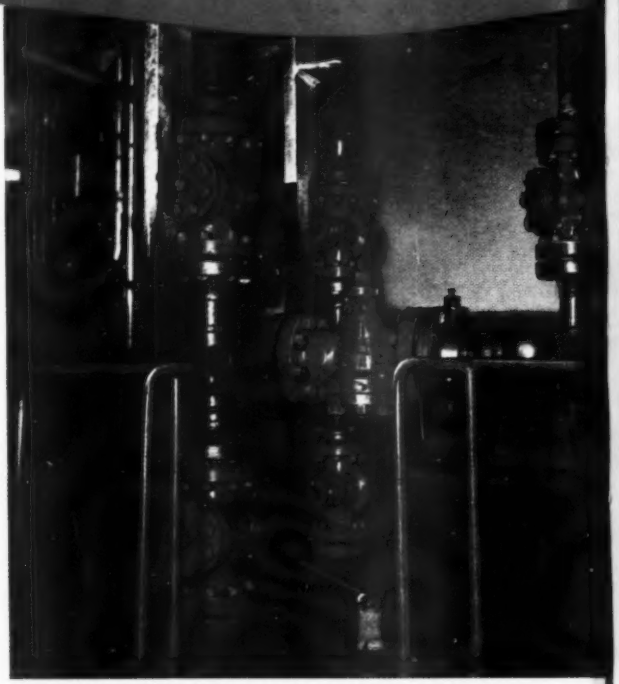
NORDSTROM VALVES IN FIELD PLANT COMPRESSOR LINE



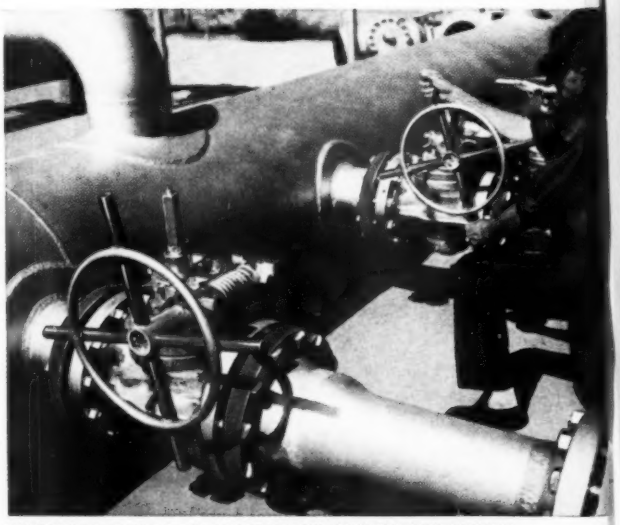
FIELD PRODUCTION MANIFOLD, NORDSTROM EQUIPPED



NORDSTROM VALVES IN MAIN GAS COMPRESSOR STATION



NORDSTROM MUDLINE VALVES ON OFF-SHORE DRILLING BARGE



NORDSTROM VALVES ON CONNECTIONS TO MAIN GAS HEADER

Nordstrom Valve Division — **ROCKWELL MANUFACTURING CO.**
400 North Lexington Avenue, Pittsburgh 8, Pa.
District Offices in all principal cities

ROCKWELL

Nordstrom VALVES

¼" TO 24" VACUUM TO 15,000 LB. TEST −150°TO+1000°

Export—Rockwell Manufacturing Co., International Division, 7701 Empire State Building, New York 1, New York

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"On or off the highway... I'd rather drive an FWD"

Throughout the oil industry, the trend is to use FWD for more and more jobs. It's rapidly becoming the first choice wherever conventional trucks have roughest going and shortest life — and wherever safety and schedules are vitally important.

"We do more actual well-servicing because we spend less time between jobs"

"Our FWD trucks last longer — because proper distribution of load and power means less strain"

"FWD extra-traction keeps our well-servicing on schedule"

GET FULL FACTS on the entire team of FWD's. Models now range from 14,500 to 60,000 GVW. 4- and 6-wheel-drives. Ask for the free FWD Model Book.

See your FWD distributor or Write FWD
THE FOUR WHEEL DRIVE AUTO CO.
Clintonville, Wisconsin
Canadian Factory: Kitchener, Ont.
World-Wide Sales and Service

America's Foremost Heavy-Duty Truck

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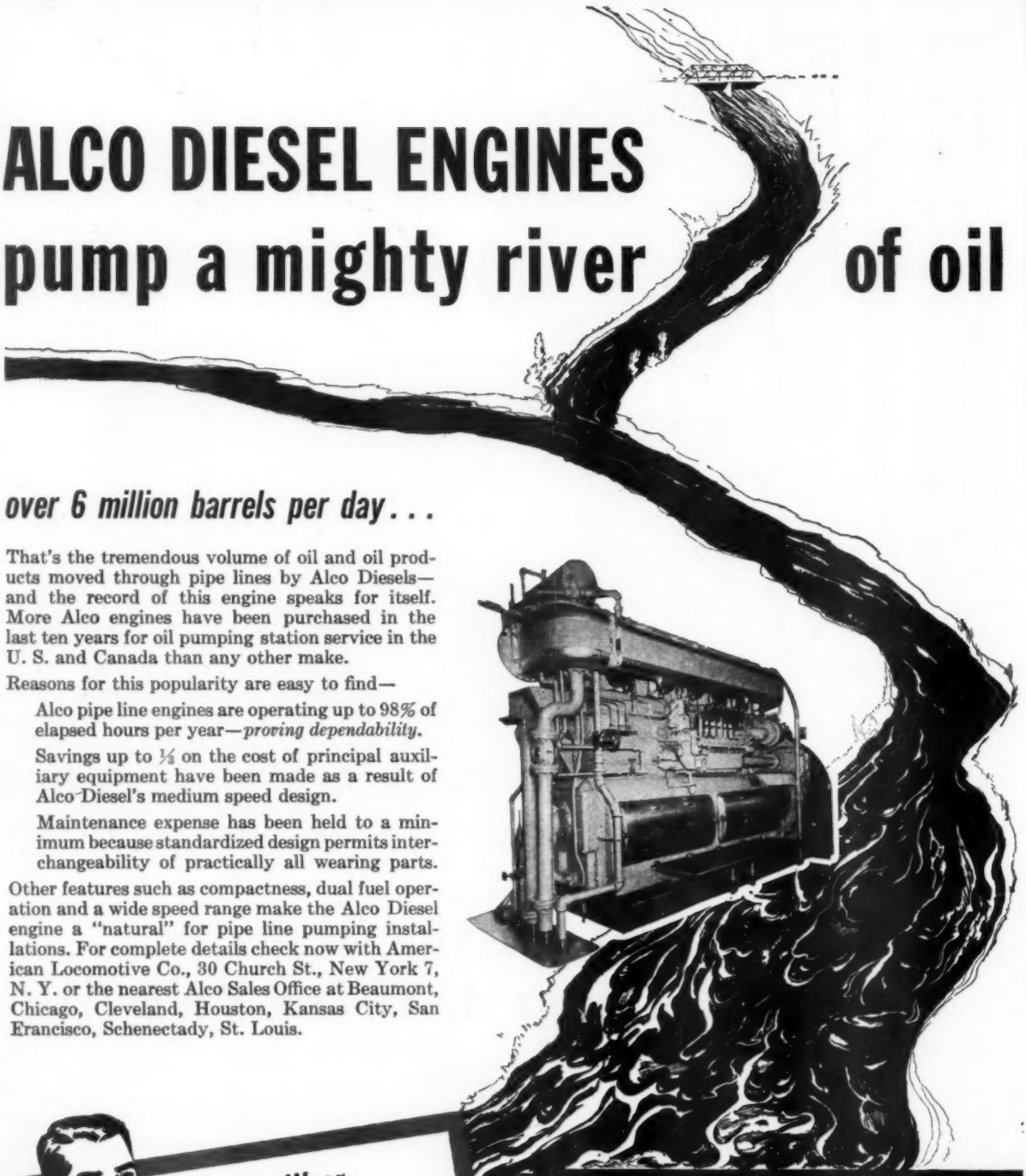
ALCO DIESEL ENGINES pump a mighty river of oil



over 6 million barrels per day . . .

That's the tremendous volume of oil and oil products moved through pipe lines by Alco Diesels—and the record of this engine speaks for itself. More Alco engines have been purchased in the last ten years for oil pumping station service in the U. S. and Canada than any other make.

Reasons for this popularity are easy to find—

Alco pipe line engines are operating up to 98% of elapsed hours per year—*proving dependability.*

Savings up to ⅓ on the cost of principal auxiliary equipment have been made as a result of Alco Diesel's medium speed design.

Maintenance expense has been held to a minimum because standardized design permits interchangeability of practically all wearing parts.

Other features such as compactness, dual fuel operation and a wide speed range make the Alco Diesel engine a "natural" for pipe line pumping installations. For complete details check now with American Locomotive Co., 30 Church St., New York 7, N. Y. or the nearest Alco Sales Office at Beaumont, Chicago, Cleveland, Houston, Kansas City, San Francisco, Schenectady, St. Louis.

Speed vs. Wear

Remember, since piston speed and journal travel per minute are both almost the same in medium speed and slow speed engines, wear is equivalent as well. Not only do you get unequalled dependability with Alco Diesels—you get long wear and low maintenance costs, no matter how difficult the service conditions.

ALCO DIESELS

Alco

THE MARK OF MODERN ENGINEERING

AMERICAN LOCOMOTIVE COMPANY

ALL OVER THE WORLD REGARDLESS OF PROCESS

TYPE 3600

KEY REFINERY FITTINGS

INCREASE OPERATING EFFICIENCY

KEY Leadership is backed by

Research

Engineering

Service

The first return bend ever installed on an oil still was designed and manufactured by the Key Company. Ever since that first installation, research and development have been a large part of the program aimed at improving the quality of the products in the interest of the customers.

Key Fittings are engineered and designed by its own Engineers for each set of working conditions. In addition to this, all field men are trained Engineers.

After manufacturing and delivery — work for you has just begun. Key Field Engineers live with your fittings until retirement. The Key Company offers supervision on installation — maintenance assistance — and is the only manufacturer in the field to encourage and sponsor reconditioning service in the interest of the oil refineries.

Write, Wire or Phone for Complete Details

KEY
COMPANY
2681 McCasland Ave.
East St. Louis, Illinois

TYPE 6500

TYPE 1900

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We've never drilled an easy well that's why we always use NATIONAL SEAMLESS

● If you're like most oilmen, you've never actually had a well that was "easy to drill." When you come right down to it, they're *all* tough. To do a good job, and still keep costs in line, you have to know your stuff. And you have to use the very best equipment and materials.

That's why so many oil field men insist on National Seamless. They can count on tough joints and strong walls—all the way down. They know that, no matter how difficult the job, National Seamless will deliver an unbeatable amount of *service per dollar.*

To a great extent, our never-ending research program is responsible for the high quality of National Seamless. It's the same program that has consistently produced National Seamless Drill Pipe with stronger joints and faster running threads. It's the same program that developed National Warm Worked Casing, renowned for its high collapse resistance and greatly increased joint strength.

Utilize the immense background of information compiled by National Tube Company . . . world's largest manufacturer of tubular products. Write today for Bulletin 15, "Seamless Drill Pipe, Casing and Tubing." Address National Tube Company, Frick Building, Pittsburgh 19, Pennsylvania.

NATIONAL TUBE COMPANY, PITTSBURGH, PA.
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

WALLS WITHOUT WELDS

USS

NATIONAL SEAMLESS
drill pipe . . . casing . . . tubing

UNITED STATES STEEL

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IT'S EASY TO SERVICE A DE LAVAL TURBINE

These features cut your maintenance costs

Every part of a De Laval Class CA Turbine is designed to facilitate inspection, maintenance and servicing.

Casing and bearings split at center line for easy removal. Rotor, carbon rings and bearings can be inspected without disturbing piping connections. Precision-machined casing joints require no gaskets.

Outside adjustment for speed controls. All you have to do is remove 2 cover plugs for access to the adjusting screws.

"Rocking chair" governor pivots seldom require replacement. The "rocking chair" type of governor pivot used by De Laval has no heavily loaded knife-edges subject to concentrated wear.

Super-smooth chrome plated shaft journals make carbon rings last longer.

Maximum interchangeability of parts between frame sizes.

De Laval Class CA Turbines are made in capacities from less than 50 to more than 1500 horsepower.

SEND FOR BULLETIN 4210-21-OG

Before you buy a turbine, be sure and get complete information on these additional De Laval features:

1. True center line support and flexible mounting for perfect alignment.
2. A choice of eight governors.
3. Balanced double-seated bonnet-type governor valves for close control of steam flow.
4. *Positive* over-speed protection entirely separate from normal speed governor for unfailing emergency shut-off.

DE LAVAL STEAM TURBINE COMPANY, TRENTON 2, N. J.

TURBINES • HELICAL GEARS • CENTRIFUGAL BLOWERS AND COMPRESSORS
CENTRIFUGAL PUMPS • WORM GEAR SPEED REDUCERS • IMO OIL PUMPS

DE LAVAL

T-21

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Cylindrical Plug gives full volume pipe flow

a.c.f. Cylindrical Plug Valves cut the man-waiting time of flow control in batch measuring. And on high volume flow, the exclusive straight-through, full pipe opening saves power. Any valve less efficient is more costly in the long run.

CYLINDRICAL FULL PIPE AREA LUBRICATED

a.c.f. PLUG VALVES

Representatives in more than 50 principal cities.

Write for catalog 4-OG, showing types and sizes. American Car and Foundry Company, Valve Division, 1501 Ferry Ave., East, Detroit, Mich.

A

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The Proof of Quality Is in PERFORMANCE

For over half a century, "HERCULES" (Red-Strand) Wire Rope has been proving its outstanding quality by the accurate yardstick of performance—on all sorts of jobs, and in one industry after another. Such *consistent* performance is not a matter of chance. Design . . . rigid tests and inspections . . . equipment . . . firm standards — are essential factors.

As "HERCULES" is made in a wide range of sizes, types and constructions—Preformed or Non-Preformed—there is in this one grade, a "right rope" for *any* heavy duty purpose.

We Invite Your Inquiries

MADE ONLY BY

A. LESCHEN & SONS ROPE CO. **5909 KENNERLY AVE. • ST. LOUIS 12, MO.**

ESTABLISHED 1857

New York 6 · Chicago 7 · Birmingham 6 · Houston 3 · Denver 2 · Los Angeles 21 · San Francisco 7 · Portland 9 · Seattle 4

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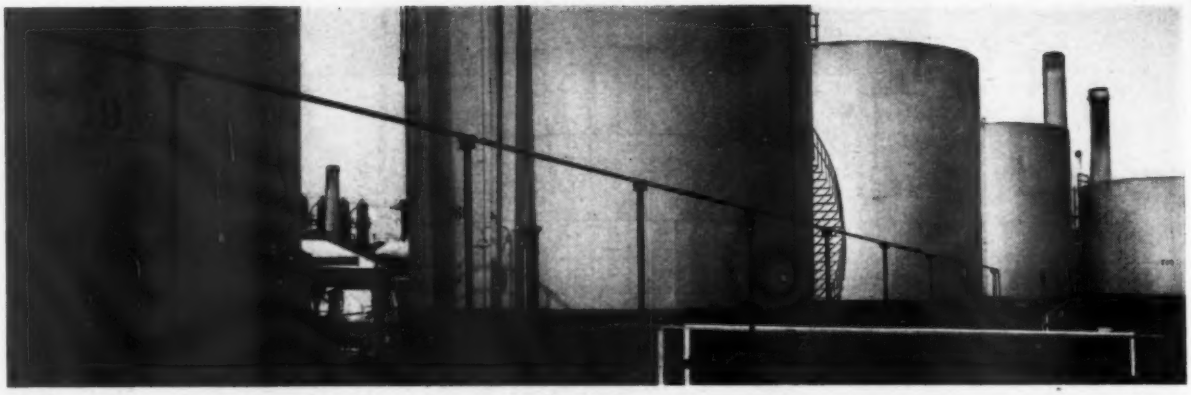

Six Thousandths of an Inch from Destruction!

Just the thickness of their protective coatings!

That's how close tanks may come to destruction from accidental acid spillage. But with coatings based on VINYLITE Brand Resins, fears are set at rest!

The tanks shown here are ample proof. Part of an oil refinery's acid plant, they are well into their second year of enduring protection by such coatings—despite overflow of sulphuric acid and sodium hydroxide—despite exposure to sulphur dioxide—despite exposure to salt air and corrosive fumes.

Expensive tank corrosion becomes virtually a thing of the past if your coatings are based on VINYLITE Resins. Savings multiply because of relief from costly shut-downs, maintenance, and replacements.

For on-shore and off-shore oil-well equipment and in chemical plants around the world, coatings based on VINYLITE Resins are resisting acids, alkalies, chemicals, sea water and salt air, abrasion, and sunlight. They remain intact after long service, retaining their integrity and bond. They are equally effective on metal and concrete. They protect equipment from contamination by contents, and contents from contamination by equipment.

For the latest technical data, and information on suppliers of chemical-resistant coatings based on VINYLITE Brand Resins, write Dept. HO-68.

Tank coatings by AMERCOAT
Amercoat Corporation, 4809 Firestone Boulevard
South Gate, California

Vinylite BRAND **RESINS**

BAKELITE DIVISION
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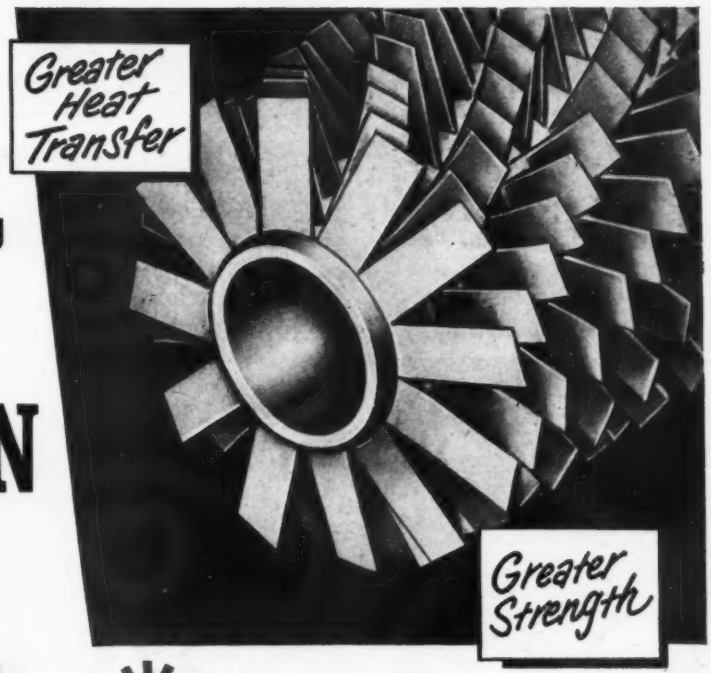
BAKELITE DIVISION, *Union Carbide and Carbon Corporation,* 30 East 42nd Street, New York 17, N. Y.

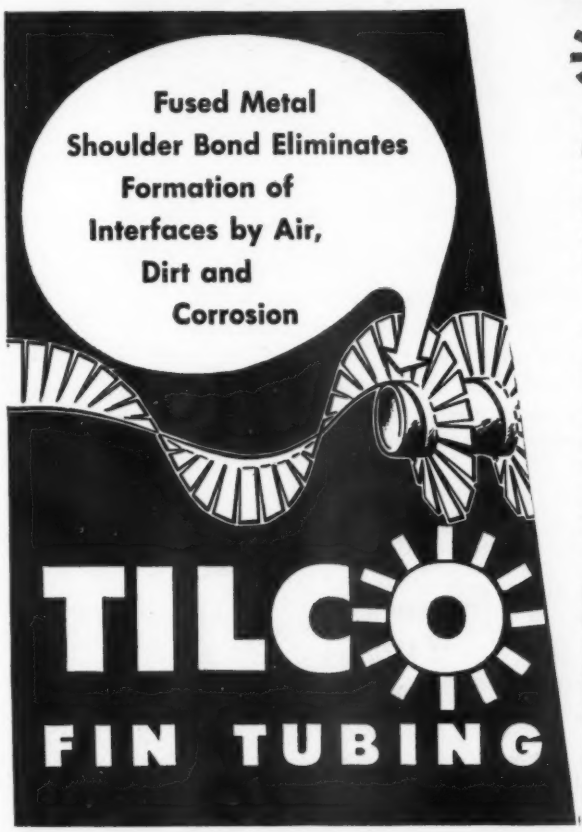
Millions of feet in actual use...

PROVE

Exclusive TILCO Fin-Shoulder Bonding

LOWERS PRODUCTION COSTS





Fin tubing is the modern way to (1) turn your waste heat into dollars (2) air cool your product when water is scarce or expensive. But now Tilco exclusive features can make your production costs drop *even more.*

Here is why: Tilco is the only strip fin tubing *shoulder bonded* by resistance welding, soldering or brazing. Its full 1/8" shoulder makes possible (1) a fused metallic bond that eliminates 3 big causes of heat transfer loss...the formation of interfaces by air, dirt and corrosion, and (2) it imparts such increased strength to the fin bond that it will not break under any conceivable service condition.

Flexible Application

Tilco's own specially designed manufacturing equipment provides flexibility that can give you a "tailor made" installation. Wide range of metals...steel fin welded to steel tube ...stainless steel fin welded to stainless steel tube...steel fin welded to cupro-nickel tube and many others. Fin spacing from 2 to 16 fins per inch...fin heights from 1/8" to 2"...tube diameters from 1/2" to 6".

Mail the coupon today for a free sample or to have a representative call. You will learn why fin tubing reaches the most advanced point of effectiveness in "Shoulder Bonded" Tilco-Fin Tubing.

TILCO-FIN DIVISION, David E. Kennedy, Inc. Dept. E
58 Second Avenue, Brooklyn 15, N. Y.

I want to know more about "Shoulder Bonded" Tilco-Fin Tubing and how it will lower steam cost more than ordinary fin tubing. I understand there is no obligation.

1. *Have a representative call* ☐
2. *Send me a free sample* ☐ *Please Check*

NAME_____

FIRM NAME_____

BUSINESS ADDRESS_____

CITY_____ STATE_____

TILCO-FIN DIVISION, David E. Kennedy, Inc., Brooklyn, N. Y.

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480 geologists and exploration experts

4100 drillers and oil field employees

6900 refinery and manufacturing employees

900 research scientists and technicians

5300 office employees

1830 people who transport our products

8100 salesmen and service station people

Thousands of hands work when you say "fill 'er up"

Most folks probably think of a corporation like ours in terms of a name . . . "Standard Oil Company of California."

Actually, a company is people . . . people working together.

In our case, 27,900 men and women work to bring you the products you buy from us. They each contribute special skills and abilities, live their own lives in many different places. You'll find their houses down the block, pass them on the street, sit next to them at a movie.

In the extremely competitive oil business, it takes a lot of people—working with many expensive tools—to bring you good products at reasonable prices. For crude oil is a bulky, sticky liquid that's hard to handle. Taking oil from the ground, refining it, transporting it and pumping it into your car or oil burner is a continuous job . . . a job that can be done most efficiently when many people pool many talents within a coordinated organization.

That's why thousands of hands work at Standard to bring you good products . . . and to make sure oil flows in steady supply to America's planes, tanks, trucks and ships in times of national emergency.

STANDARD OIL COMPANY OF CALIFORNIA

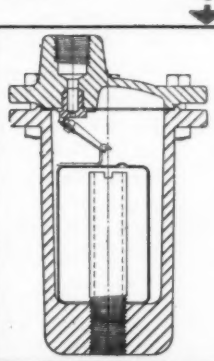
plans ahead to serve you better

Your progress and oil progress go hand in hand

"Here's a Forged Steel Trap . . . for only $14.00 list"

SMALL PRICE
BIG BENEFITS

SAFETY . . . DEPENDABILITY



Cross section of an Armstrong No. 3211 forged steel trap. Forged cap and body, compressed graphited asbestos gasket, all stainless mechanism. This trap will take high temperature and shock without danger of fracture.

SMALL SIZE . . . LIGHT WEIGHT

NOW, for many applications, refineries and natural gasoline plants can have the additional safety of a forged steel steam trap for only a few dollars more than a cast iron trap of comparable size. The Armstrong No. 3211 trap illustrated will withstand fire or explosion without danger of fracture. It is the baby of the Armstrong forged steel line, a low priced trap for working pressures up to 250 psi; design pressure, 450 psi. Capacity range 750 to 1000 lbs/hr continuous. ½" or ¾" pipe connections. Diameter 4¼"; height 7"; weight 8 lbs. This trap is a natural for refinery and natural gasoline plant service.

For higher pressures and larger capacities Armstrong builds a complete line of heavy duty forged steel traps. Ask your nearby Armstrong representative to quote on the traps you need now.

ARMSTRONG MACHINE WORKS
868 Maple St., Three Rivers, Mich.

SEND FOR your copy of the Armstrong Steam Trap Book giving complete data and prices on all Armstrong steam traps, both forged and cast bodies for all pressures, all applications. This 36-page book is a valuable reference for any engineer working with selection and installation of steam traps.

ARMSTRONG STEAM TRAPS

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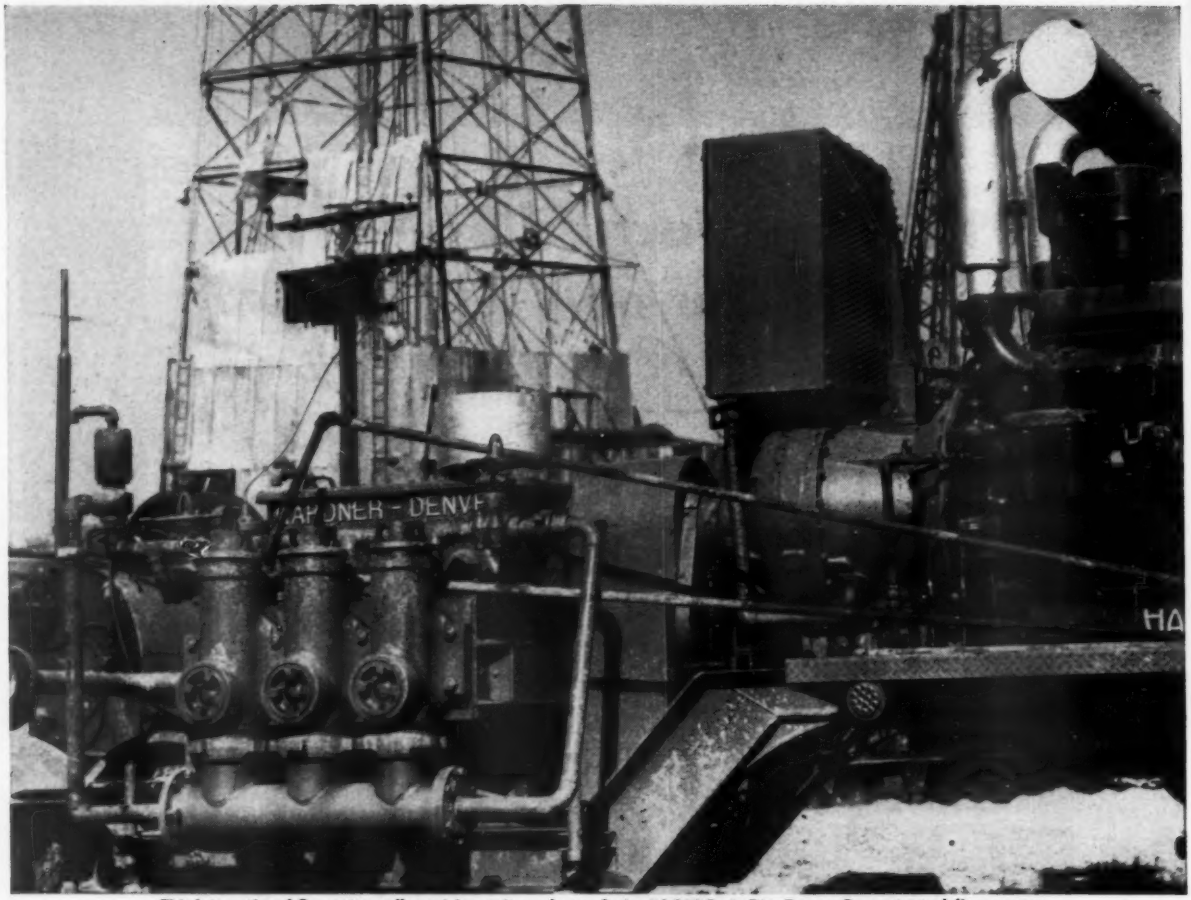


This International Cementer well-servicing unit employs a Series 16,000 Twin Disc Torque Converter to deliver power for the varying torque requirements of pumping cement, down the well or applying pressure for squeeze jobs.

To Make the Big Rigs BIGGER

When you want up to 1,000 horsepower handled with steam smoothness, specify the Series 16,000 Twin Disc Hydraulic Torque Converter.

For this unit—the only torque converter in its class multiplying engine torque more than five times—is designed especially to expand the work capacity of big oil field equipment . . . designed especially to handle the 250 to 1,000 horsepower needed for bigger loads.

Every operator who has used Twin Disc Hydraulic Torque Converters can tell you the advantages—no gear-shift guesswork . . . uninterrupted acceleration from dead stop to capacity . . . shocks and vibrations eliminated . . . faster, cheaper operation all around.

Twin Disc Hydraulic Torque Converters are available in 44 models in three series, including the Series 16,000. Write the Hydraulic Division for Engineering Bulletin 135-C for more engineering details. TWIN DISC CLUTCH COMPANY, Racine, Wisconsin (Hydraulic Div., Rockford, Illinois).

For Deep-Hole Drilling

For deep-hole drilling, down to 14,000 or 15,000 feet or deeper, specify a Series 16,000 Twin Disc Torque Converter, (Lysholm-Smith type), the *only* unit in the 250-1000 hp class that multiplies engine torque more than *five times*.

SPECIALISTS IN INDUSTRIAL CLUTCHES SINCE 1918

U-30

ONE portable drilling unit for deepest well drilling

PORTABLE

SAFE

RUGGED

DEPENDABLE

ECONOMICAL

Moving day is a comparatively light chore when you use the U-30. That's why, in one year's time, UNIT RIG'S Big U-30 is making such a hit with drillers. The U-30, like all UNIT RIG equipment, is a compact unit, enclosed in a heavy steel plate case, and can be transported to location ON ONE TRUCK.

Investigate the U-30 for all deepest well drilling jobs. The performance of the U-30 in actual drilling operations has actually amazed even the most critical and particular drillers hardened by years of operating many types of equipment.

Get the Facts . . . Write for U-30 Bulletin

UNIT RIG & EQUIPMENT CO.
TULSA, OKLAHOMA U.S.A.

DESIGNED FOR THE JOB . . . .

Exclusive Export Representative
MID-CONTINENT SUPPLY CO.
42 Broadway, New York City
Cable Address MIDUNITRIG

XUM

DESTINATION U. S. A.

It takes a lot of steel pipe to keep the wheels of industry turning in normal times—*more* when the No. 1 industrial country of the world becomes the arsenal of Democracy. That's why you'll find Wheatland Pipe, in greater quantities than ever before, en route to farms and factories, plants and mills all over the U. S. A. We at Wheatland are proud of the part played by the "pipe with the yearmark" in contributing to the health, comfort, *and security of the nation.*

-pipe with the yearmark!

WHEATLAND TUBE COMPANY

BANKERS SECURITIES BLDG., PHILADELPHIA 7, PA.

LET PB TAKE THE WHIPPING!

YOU KNOW THE RESULTS of excessive vibration and whip in the fast line of your rig . . . how line wears out quicker because of uneven spooling and pile-up on the drum and unnecessary friction against the fast sheaves. *PB can save you money by taking the whip out of the wire line on any well you drill.*

NEW PB ROLLETTE WIRE LINE GUIDE

FOR ALL AVERAGE DEPTH DRILLING

8-POINT CONTACT! Eight rollers contact the line, stabilize it against damaging whip and vibration, and insure even line spooling on the drum.

ABSORBS WHIP! All line whip absorbed by the rollers is transmitted to the Rollette body and hanging assembly.

NON-CLOGGING! Rollers of solid, tough, field-proven PB rubber operate in an all-steel body designed so that rollers cannot clog or throw oil on the crew.

FREE SPINNING! Rollers are molded integral with heavy duty lubricated-and-sealed ball bearings that insure a free-running line at all times.

SAFE! Rollette design and construction are such that the rollers cannot, under any conditions, fall out of the body.

FOR YOUR DEEP DRILLING

use the PB Roliguide, especially built for the heaviest duty deep drilling operations. Handles 1½" wire line, has all the construction features you want for the toughest well conditions.

Your nearby PB representative has detailed information on the new PB Rollette Wire Line Guide, supplied complete as pictured, made to meet *most* of your drilling requirements. *See him today.*

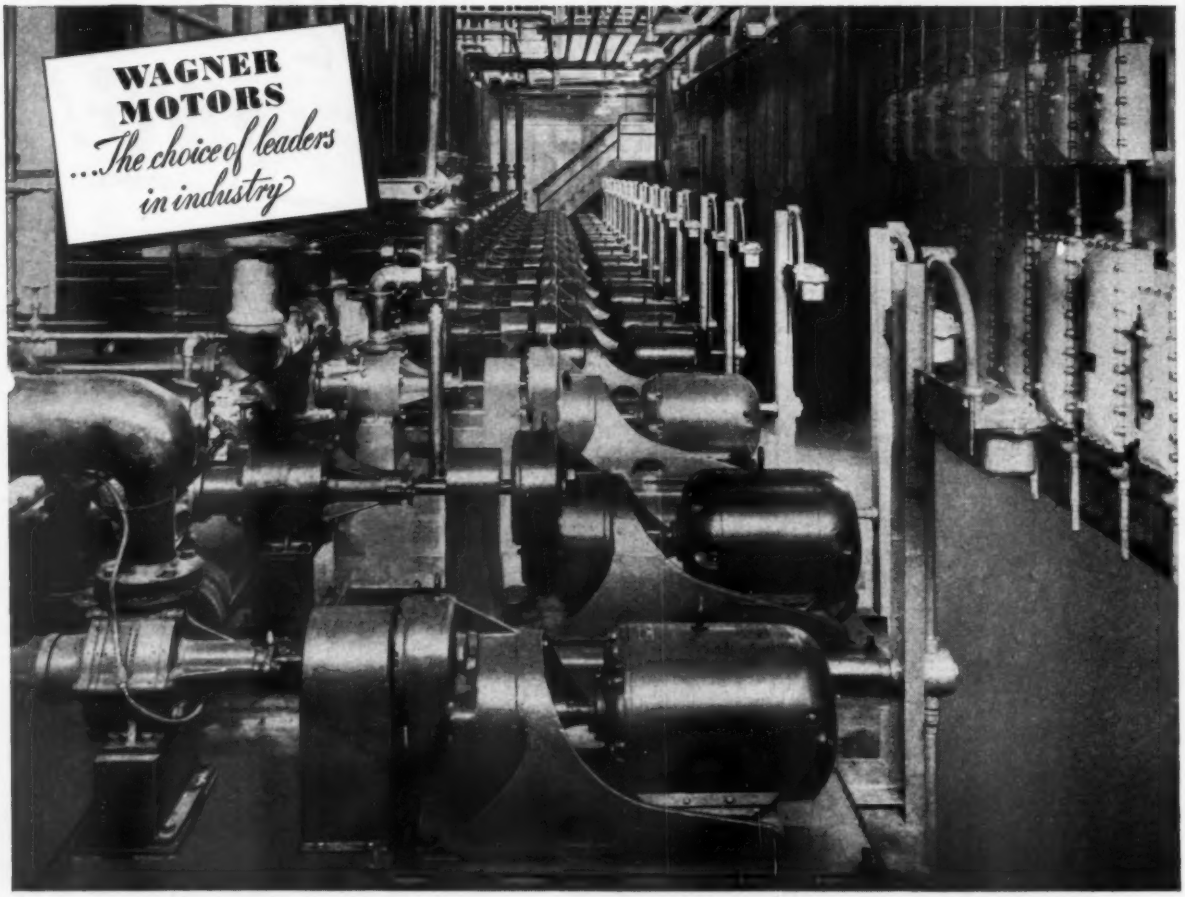
Patterson-Ballagh

Division of Byron Jackson Co.

MAIN OFFICE: 1900 EAST 65th STREET

LOS ANGELES 1, CALIFORNIA

XUM

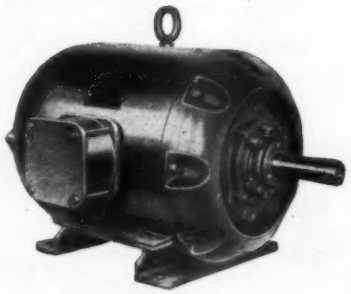


Wagner explosion-proof motors provide safe, sure, power for Sinclair

The Sinclair Refining Company in Houston handles almost every type of oil and gasoline imaginable . . . even producing coke from petroleum, which closely resembles coal coke, and is used by steel plants in their open hearth processes. The latest addition to this refinery is a barrel house and grease plant where products from the refinery are compounded and canned.

Shown above is a row of the pumping units that handle all the various oils from the refinery field which are brought into the barrel house for compounding and storage. The entire installation is powered by dependable, efficient Wagner Type HP Motors, is explosion-proof, and each pump is individually push button controlled.

Wagner Type HP Motors are approved by Underwriters Laboratories for Class I Group D hazardous locations . . . they are fully protected against adverse conditions . . . and they are always reliable. If you need motors for use where explosive gases, fumes, vapors or combustible substances are present, investigate the many advantages of Wagner Type HP Motors. Bulletin MU-185 gives full information.



Wagner Electric Corporation
EST. 1891

WAGNER ELECTRIC CORPORATION
6389 Plymouth Ave., St. Louis 14, Mo., U.S.A.

ELECTRIC MOTORS • TRANSFORMERS • INDUSTRIAL BRAKES
AUTOMOTIVE BRAKE SYSTEMS — AIR AND HYDRAULIC

BRANCHES IN 31 PRINCIPAL CITIES

MORE POWER FOR LESS MONEY

assured by higher speeds and outstanding mechanical excellence!

Check these Features!

- All friction surfaces *Super-finished*
- Statically and dynamically balanced crankshaft
- Sodium cooled exhaust valves
- Stellite exhaust valve seat inserts
- Stainless steel valve springs
- Chrome top piston ring
- Completely waterproofed ignition
- By-pass thermostat cooling system

Chrysler Industrial 12—one of eight basic models

THE FACT that a higher speed engine can out-perform all others has long been established. Today, after years of field operation in every type of gasoline powered equipment, it has been conclusively shown that Chrysler Industrial Engines *out-last* and *out-economize* all other similarly rated engines. The reason lies in the outstanding achievements of Chrysler engineering and Chrysler research in higher alloy steels. And because of Chrysler mass production Chrysler Industrial Engines *cost less!* See your Chrysler Industrial Engine Dealer, or write us. ***Industrial Engine Division, Chrysler Corporation, Detroit 31, Michigan.***

CHRYSLER

Industrial Engines and Power Units

CHRYSLER INDUSTRIAL ENGINES

HORSEPOWER WITH A PEDIGREE!

Service Available Everywhere

XUM

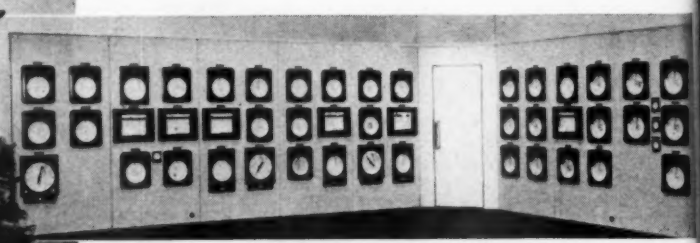
Sun Oil, Toledo, goes on stream with first big Houdriflow units...

... under Foxboro M-40 Control

When Sun Oil Company's new Plant 5 at Toledo, Ohio, went on stream last May, 81 Model 40 Controllers took over critical control functions. Without any manual "juggling", process variables came directly to their control points, because M-40 met the preset values so exactly. And the inherent accuracy of the M-40 *held* them there, continuously!

This first major installation of Houdriflow "cat" crackers offers another outstanding example of the petroleum industry's preference for Foxboro M-40, "the finest modern controller"!

The Foxboro M-40 Controller gives you the benefit of the most advanced developments in pneumatic instrument design. Its rigid unit construction and almost frictionless moving parts result in greater power, accuracy and response. Available for temperature, pressure, flow, level and other applications.
Write for details. **The Foxboro Company, 60 Neponset Ave., Foxboro, Mass., U.S.A.**



Section of Plant 5 control room at Sun Oil showing a few of the 81 Foxboro M-40 Controllers.

Sun Oil's revolutionary new Plant 5 at Toledo—a 308-ft. quadruple-reactor catalytic cracking unit.

FOXBORO REG. U. S. PAT. OFF. **CONTROLLERS**

XUM

FIRST *NEW* DEVELOPMENT
IN SINGLE DECK ROOFS
IN 20 YEARS

GRAVER

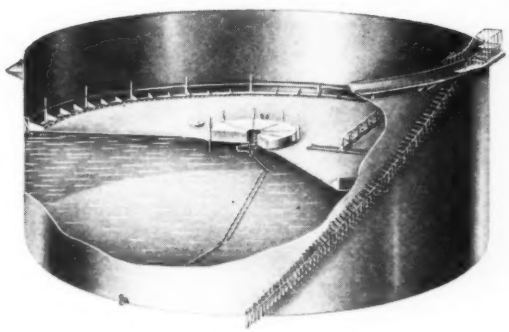
CENTER-WEIGHTED FLOATING ROOF TANKS

Patented design combines the stability and the vapor-saving, corrosion-resistant features of the double-deck floating roof with the more economical aspects of the conventional pan-type roof.

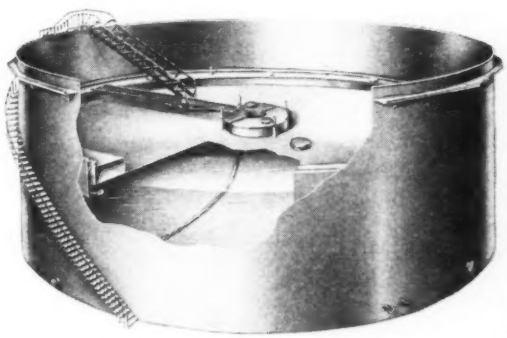
NEW FEATURES FOR IMPROVED PETROLEUM STORAGE

- Non-tilting, non-sinking; center of gravity below center of buoyancy.
- Fully effective single seal—no springs; nothing to get out of order.
- No air pockets under deck; full rim immersion—roof floats directly on product—no space for vapors to form.
- Requires *less steel* to build.
- Positive drainage at center due to increasing slope.
- Clear deck permits full accessibility, easy snow removal.
- Proved construction—tested in actual installations.

Send for New Book on Graver Center-Weighted Floating Roofs.



PAN-TYPE Center-Weighted Floating Roof . . . for southern climates where rain is the only weather problem.



PONTOON Center-Weighted Floating Roof . . . for northern climates involving snow, ice and rain.

FABRICATED PLATE DIVISION

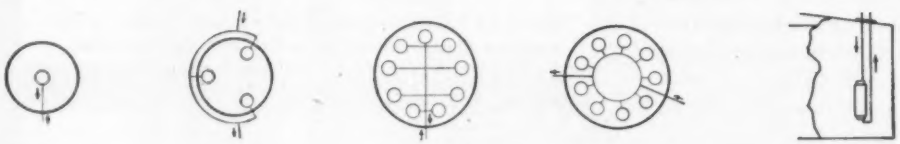
GRAVER TANK & MFG. CO., INC.

EAST CHICAGO, INDIANA

NEW YORK • PHILADELPHIA • CHICAGO
DETROIT • CINCINNATI
CATASAUQUA, PA. • HOUSTON • SAND SPRINGS, OKLA.

BROWN FINTUBE
Thermo-Flo
TANK HEATERS

easy to install in new—or existing—tankage



Single Heater Installation | Heaters Manifolded on the Outside | Heaters Manifolded on the Inside | Heaters Manifolded on the Inside | Heater Mounted on Roof Manhead

Users report that the cost of a group of Brown Fintube Thermo-Flo Tank Heaters — plus their installation — is less than the cost of just installing a bare pipe heating coil of equivalent capacity.

● Brown Fintube Thermo-Flo Tank Heaters are vastly superior to the old method of heating with a coil of bare pipe installed in the bottom of the tank. Thermo-Flo Heaters mount vertically, practically eliminating any depositing on the tubes. They avoid heating through a layer of sediment, and set up a thermal flow or siphon within the tank that assures thorough, rapid heating, avoiding stratification.

Thermo-Flo Heaters are compact units. They pass through a standard manway with ample clearance. They can be installed quickly; disconnected easily; and cleaned or repaired *outside* the tank.

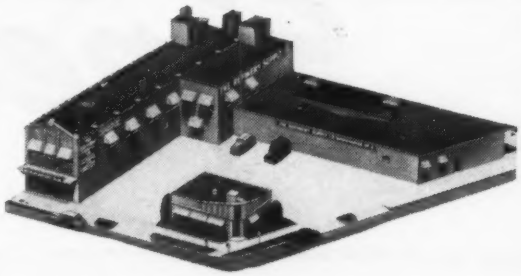
The TF-20 Heaters, pictured above, have 265 square feet of surface. They are highly endorsed by operating and maintenance men, built in large quantities and are moderately priced. Available in mild steel, stainless steel, monel, inconel, aluminum, admiralty and other non-ferrous alloys to meet any requirement.

Write for Bulletin No. 491. It gives full details.

THE BROWN FINTUBE CO.
ELYRIA, OHIO

FINTUBE HEAT TRANSFER PRODUCTS

PIONEERS...



ON October 4, 1918, The Refinery Supply Company opened its doors at the corner of Third and Cincinnati in Tulsa. During the same year W. A. Schlueter applied for patents covering the first control application ever designed for vapor outlet control towers. This design was destined to become the principal control application in petroleum refining.

TO identify The Refinery Supply Company's patented and manufactured precision instruments, two trade-marks were designed and registered. The first known as R. S., identifies The Refinery Supply Company; the second, AC-ME signifies a combination of the words "ACcurate" and "MEasurements."

R. S. Dead Weight Gauge

AFTER thirty-two years of service The Refinery Supply Company's reputation as one of the leading manufacturers of highly specialized types of scientific apparatus has spread 'round the world. Its strongest wish is to continue its long friendship with you members of the oil industry.

WRITE FOR BULLETIN 50

Refinery Supply Co.

621-23 E. 4th St. Tulsa 3, Oklahoma

Laboratory Apparatus
Instruments Chemicals

MANUFACTURER OF R.S. SPECIALTIES

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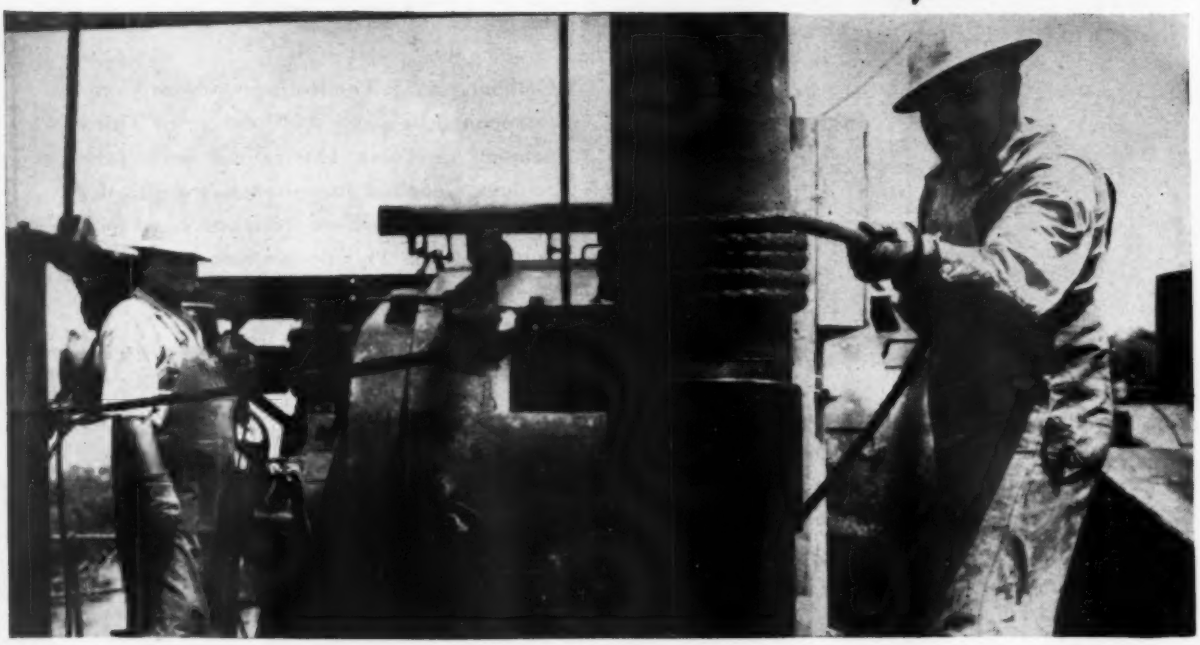
Speed-up ... with Republic



SPINS IN FLUSH ... or to within one turn

● On one Louisiana rig, 4980 feet of 7" O.D. J-55 Republic Electric Weld Casing was set in an 8¾" hole in just 5½ hours. One big reason why this job went so smoothly is that the spinning line consistently spun the joint up to *within one turn* of the coupling. *Many times it spun up flush with the coupling.*

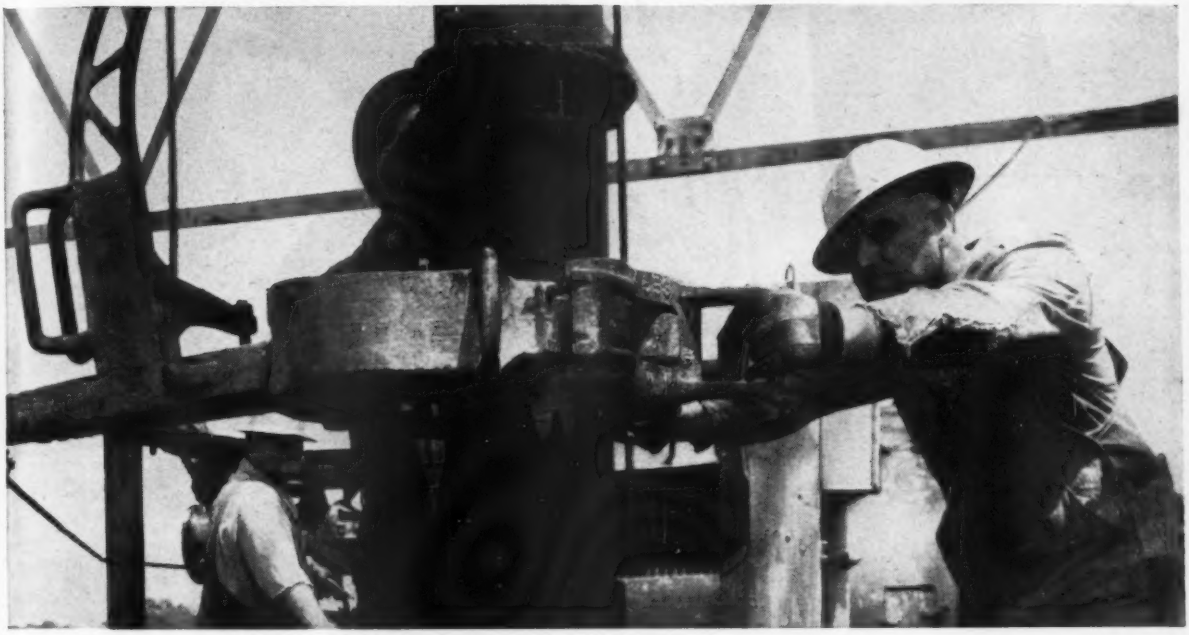
Spinning performance like this requires uniformly clean, accurate threads —the kind you find on every length of Republic Electric Weld Casing and Tubing. They're accurate in size, depth, lead and taper, and sized to insure proper stand-off. Couplings are threaded with equal care and accurately matched. A uniform depth of tough, sound steel beneath thread roots all around the pipe guards against pull-outs.

Republic Electric Weld Casing and Tubing are made from flat-rolled steel, both sides of which are inspected. Thus, the surface which becomes the inside wall is free from hidden defects.

REPUBLIC STEEL CORPORATION
GENERAL OFFICES • CLEVELAND 1, OHIO
Export Department: Chrysler Building, New York 17, New York

the Make-up

Electric Weld Casing



TONGS UP TIGHT . . . in just 1½ turns

● In this fast 906 foot-an-hour casing run, an average of only 1½ to 2 turns was required for tonging-up. Performance like this really cuts your time spent in running casing . . . saves plenty of man-hours . . . gives you more time for makin' hole.

But, that's not all! Republic Electric Weld Casing is made from high ductility steel, fully normalized for uniform structure and cold sized for high yield strength. Walls are uniformly thick and uniformly round. They offer top protection against the dangers of collapse.

For every job where you can't afford to stall—and where you want high resistance to pull-outs and collapse—remember to specify Republic Electric Weld Casing and Tubing.

REPUBLIC *Electric Weld* **NORMALIZED CASING AND TUBING**

REPUBLIC STEEL

Other Republic Products include Line Pipe—Carbon, Alloy and Stainless Steels—Upson Studs, Bolts and Nuts—Electrunite Heat Exchanger Tubes

XUM

Dependable Selectivity...

Efficient H_2S removal in the presence of CO_2

Dependable, low-cost removal of H_2S in the presence of large volumes of CO_2 is a primary advantage of the Shell Phosphate Process. All but harmless amounts of H_2S are removed while most of the CO_2 is left untouched.

Important too is the fact that the treating process has no harmful effect upon subsequent processing operations. The treating agent is inorganic . . . non-contaminating to hydrocarbons.

Low operating costs are the rule with the Shell Phosphate Process. Since a minimum of CO_2 is removed, steam regeneration of the treating solution costs less. Also, because the regenerated H_2S is in a relatively high concentration, the cost of conversion to solid sulphur or sulphuric acid is greatly reduced.

The Shell Phosphate Process is available to any operator under license from the Shell Development Company . . . together with experienced engineering service for its design, installation, and operation.

SHELL

SHELL DEVELOPMENT COMPANY

50 West 50th Street, New York 20, N. Y.

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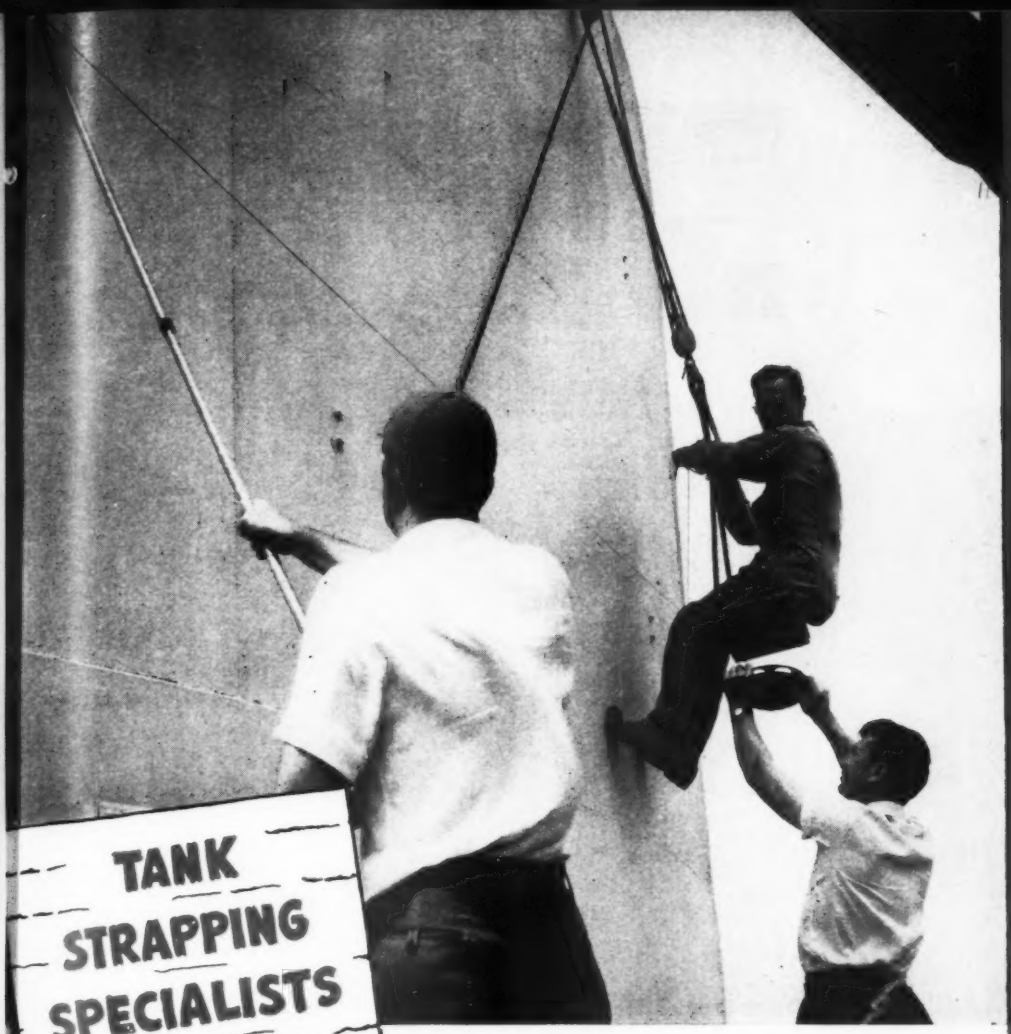

Every oil man knows there are 42 gallons in one *barrel of oil*. But — do you know how many barrels are in your storage tanks? . . . Be *sure* by employing CHAS. MARTIN & COMPANY to strap and calibrate your tanks. Our tank tables are *accurate* — computed from measurements made by experienced tank strappers, who follow the latest A.P.I. Codes . . . The cost is *nominal* — equal to the value of only a few barrels of oil per tank . . . Call our nearest office for *prompt* and *dependable* tank strapping and inspection service.

Tank Strappers
B. Brennan, Jack Painton
and Dick Stone

New York, N. Y.
Boston, Mass.
Fall River, Mass.
Providence, R. I.
Tiverton, R. I.
Chicago, Ill.
Philadelphia, Pa.
Marcus Hook, Pa.
Paulsboro, N. J.
Bayonne, N. J.
Elizabeth, N. J.
Baltimore, Md.
New Orleans, La.
Baton Rouge, La.
Lake Charles, La.
Port Arthur, Texas
Beaumont, Texas
Houston, Texas
Baytown, Texas
Texas City, Texas
Freeport, Texas
Corpus Christi, Texas
Brownsville, Texas
Helena, Ark.
San Pedro (Port of Los Angeles), Calif.
San Luis Obispo, Calif.
San Francisco, Calif.
Seattle, Wash.
Tampico, Mexico
Havana, Cuba
Aruba & Curacao, N.W.I.
Trinidad, B.W.I.
Caripito, Puerto La Cruz
Las Piedras, Venezuela
Ras Tanura, Saudi Arabia

Chas. MARTIN & Company

INSPECTORS OF PETROLEUM

World's First Petroleum Inspectors

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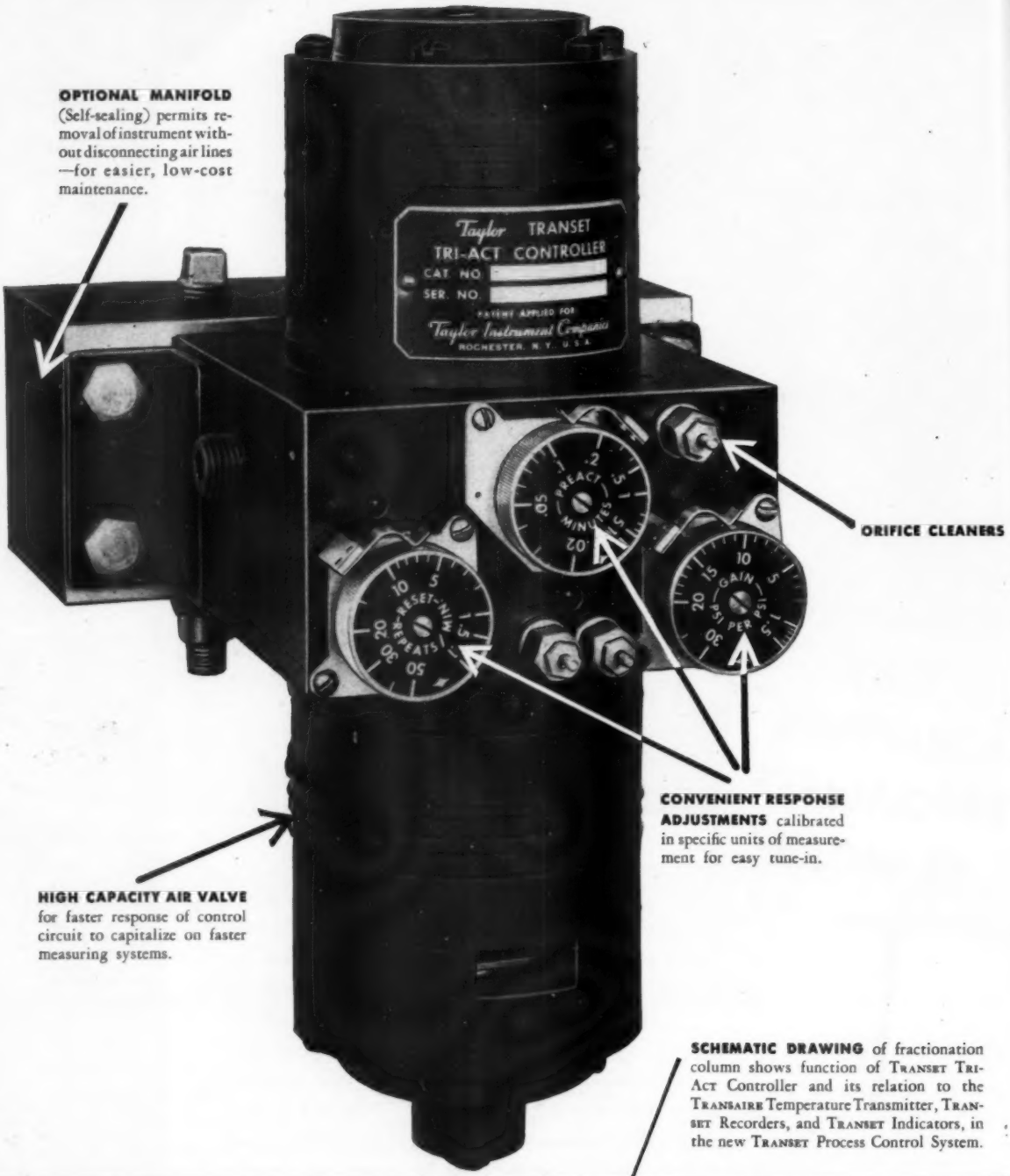


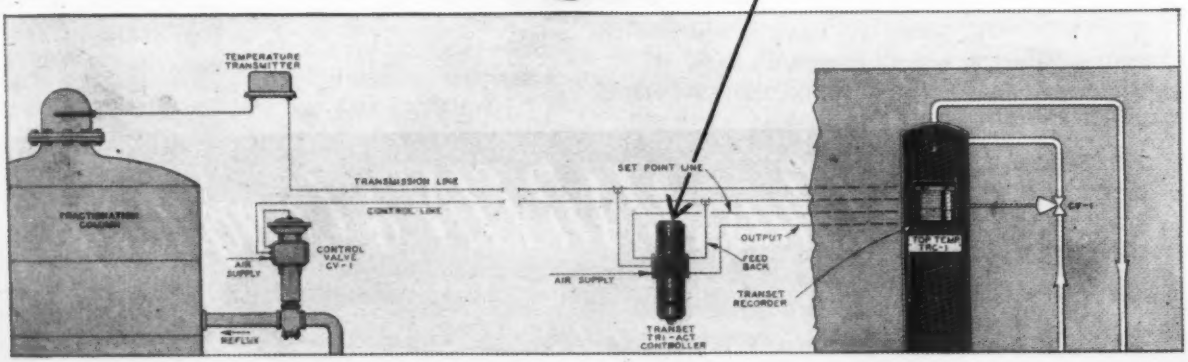
OPTIONAL MANIFOLD (Self-sealing) permits removal of instrument without disconnecting air lines —for easier, low-cost maintenance.

ORIFICE CLEANERS

CONVENIENT RESPONSE ADJUSTMENTS calibrated in specific units of measurement for easy tune-in.

HIGH CAPACITY AIR VALVE for faster response of control circuit to capitalize on faster measuring systems.

SCHEMATIC DRAWING of fractionation column shows function of TRANSET TRI-ACT Controller and its relation to the TRANSAIRE Temperature Transmitter, TRANSET Recorders, and TRANSET Indicators, in the new TRANSET Process Control System.



New Taylor Transet* TRI-ACT* CONTROLLER!

A Force-Balance Controller with a New Circuit . . . a New Concept in Process Control

GIVES YOU

1. START-UP WITH *NO* OVERPEAKING
2. BENEFITS OF AUTOMATIC RESET WITHOUT ITS "EVILS"
3. FASTER RECOVERY ON LOAD CHANGES

What It Is—A force-balance controller with a new circuit for pneumatic control systems. The new control circuit combines *two* proportional bands, one with rate action in a closed loop ahead of automatic reset. The first band is shifted by the rate action, and the second band is shifted by the automatic reset. This provides control never before believed possible.

What It Does—The new circuit in the TRANSET TRI-ACT Controller permits 4 times faster reset rate and 4 times faster rate action (PRE-ACT) than conventional instruments! The composite effect of the three responses allows start-up and pneumatic setting with No OVERPEAKING! The faster response settings allow the use of rate and reset responses, *with stability*, on processes where these effects were needed but could not be used.

OTHER HIGHLIGHTS

- Can be locally or panel mounted
- Wider range of response adjustments
- Light weight
- Built-in air strainers

TRANSET TRI-ACT Controller is the latest step in the TAYLOR TRANSET system of control: TRANSAIRE* Transmitters, TRANSET Recorders and Indicators. It creates new standards in accurate pneumatic transmission systems for temperature, pressure, flow or liquid level control.

Write for Bulletin 98097 or, better still, order now from your Taylor Field Engineer! Taylor Instrument Companies, Rochester, N. Y., or Toronto, Canada.

Instruments for indicating, recording and controlling temperature, pressure, humidity, flow and liquid level.

*Trade-Mark

Taylor Instruments
MEAN
ACCURACY FIRST
IN HOME AND INDUSTRY

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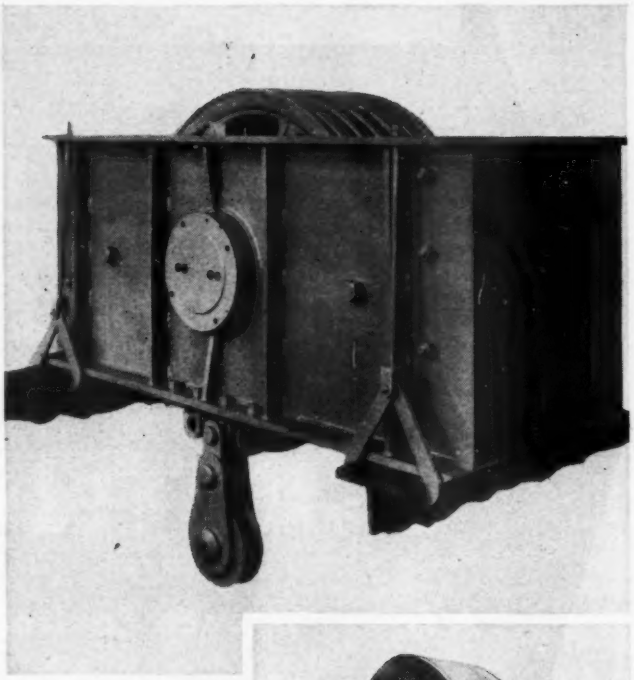
NEW DESIGN

pays off in trouble-free operation



A little over a year ago, Beaumont Iron Works introduced its new Dreadnaught Type KN Crown Block with its companion Dreadnaught Type PN Traveling Block. The completely new ideas embodied in the design of this block combination made such excellent common sense that the Dreadnaught pair was an immediate success. Repeat orders coming in from major customers are the best endorsement of this new design.

NO OTHER CROWN BLOCK HAS ALL THESE FEATURES...

Space Saver—Centerline and narrow centers between sheaves permit block to be hoisted through water table in one piece.

Beam Support—Large diameter center pin mounted in box built into beam *on its center line.* New design provides extremely sturdy and rigid support and reduces over-all height of block.

Two Mountings—As center pin is on center line of beam, *either flange* of beam can be set on water table beams.

Four Positions—By turning block around, deadline sheave can be set in any of *four different positions* to minimize Brinelling effect on races, increasing life of bearings in end sheaves.

Bearing Life—A new idea in bearing design. Row of ball bearings in bronze retainers placed between each sheave. Acts as thrust bearings, resisting both end-wise movement and twisting effect caused by line passing between crown and traveling block.

All-around Protection—Labyrinth type seals between each sheave serve as grease seals and dust guards.

Rated Capacity—360 tons at 100 rpm—600 tons at 10 rpm.

STREAMLINED SPACE-SAVER TRAVELING BLOCK

Extreme Narrow-Width—Streamlined design did the "impossible." Although sheaves and bearings are of larger diameter, and maximum load capacity is built into design, the PN Traveling Block is so narrow and compact it does not restrict pipe racking space on deepest holes.

New Thrust Design—Each sheave mounted on radial roller bearing, separated by row of spherical ball bearings. Adds to bearing life and prevents radial rollers from skewing as *they carry no thrust load on the ends.*

New Strength—Load carried through rolled steel side plates. No spacer plates employed. The becket, capable of carrying load of one line, is buried within block.

Rated Capacity—300 tons at 100 rpm—500 tons at 10 rpm.

EXPECT the Best from BIW—Builders of Proved Drilling and Production Equipment for 40 Years.

WANT TO KNOW MORE?
call or wire ATLAS collect.

BEAUMONT
IRON WORKS COMPANY
Subsidiary, American Locomotive Co.

Exclusive Sales Agents
ATLAS
ENGINEERING WORKS
Houston & Beaumont, Texas

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is
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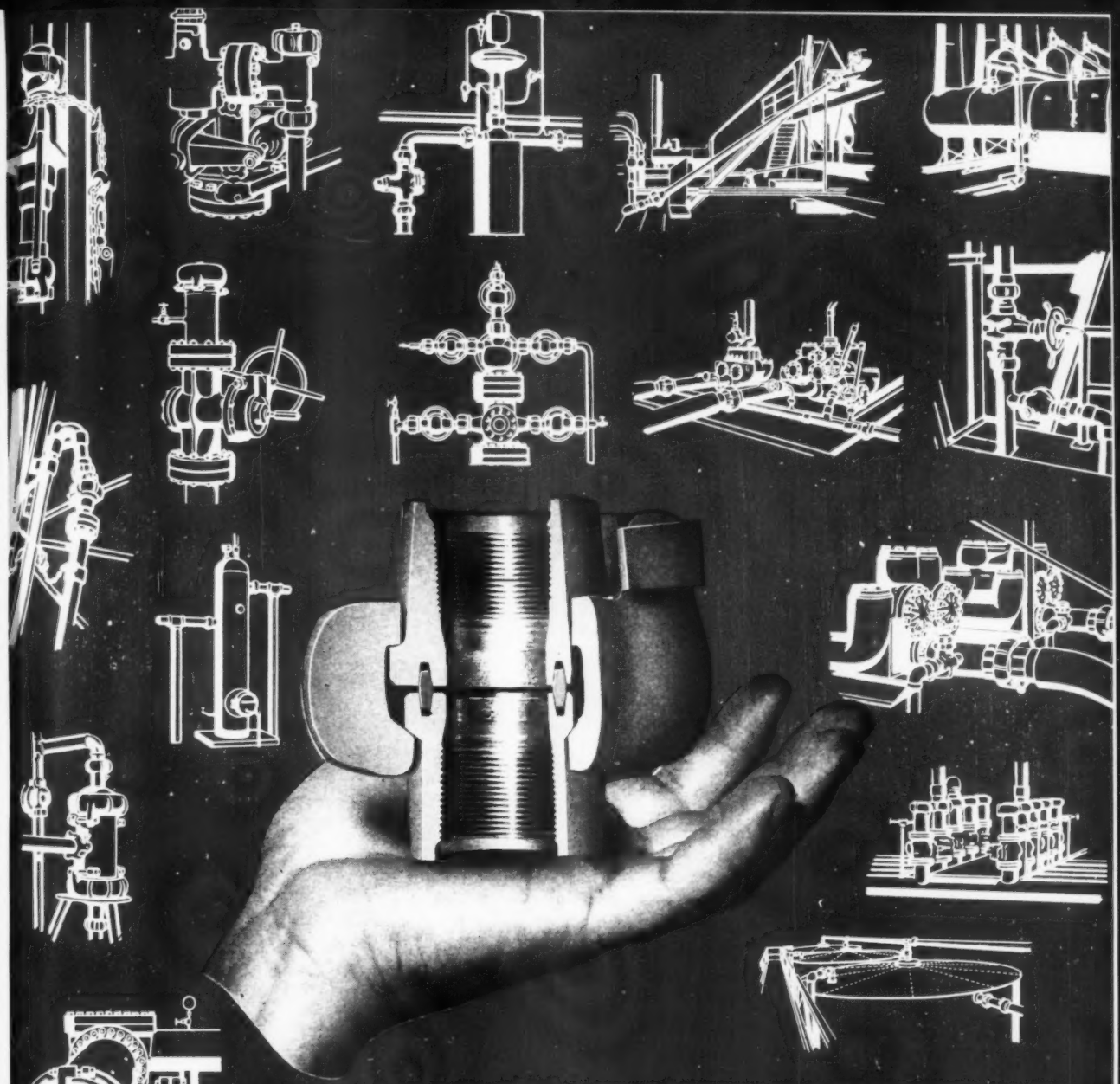


The same unique UNIBOLT design, which places more metal in shear and thus provides the highest factor of safety, is offered in a wide range of couplings — forged steel with renewable metal ring gasket for high pressures; cast steel with renewable resilient gasket or tongue and groove seat for pipe line service; the original "big inch" type with blanking plug for pump suctions; and malleable with renewable resilient gasket or tongue and groove seat for medium and low pressure service.

Consult your Composite Catalog for complete mechanical details, or descriptive literature will be gladly sent on request.

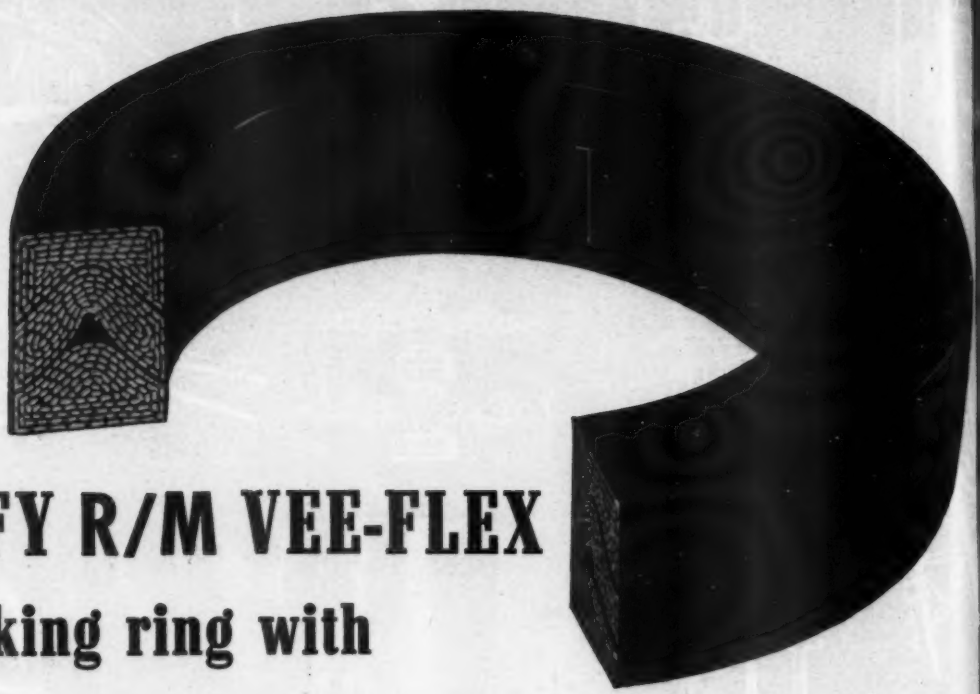
UNIBOLT

The versatile UNIBOLT COUPLING is a natural for practically every coupling requirement in drilling, producing and pipe line service

THORNHILL-CRAVER CO.

HOUSTON, UNIBOLT **TEXAS**

XUM



SPECIFY R/M VEE-FLEX

the packing ring with the automatic sealing action

R/M Vee-Flex Packing Rings have been used for years to insure efficient sealing against gasoline, oil, steam, water, air, and hydraulic fluids. They are used in heavy-duty valves, steam-driven equipment, oil pumps, hydraulic lifts, and similar equipment. They are available in sizes for practically all applications in modern machinery.

The rings are designed so that fluid or gas pressure automatically spreads the lips and thus increases the efficiency of the seal against rod or stuffing box wall. When pressure is released, the rings contract, thus decreasing friction and making possible longer service.

R/M Vee-Flex Rings nest together in sets, providing a multiple seal in limited space. "Finger-tight" adjustment is all that is necessary to insure sealing.

Fill out the coupon below for information on Vee-Flex Rings.

RAYBESTOS-MANHATTAN, INC.

PACKING DIVISION, MANHEIM, PA.

FACTORIES: Bridgeport, Conn.; Manheim, Pa.; No. Charleston, S.C.; Passaic, N.J.

RM

RAYBESTOS-MANHATTAN, INC. 0-110
Packing Division, Manheim, Pa.

Gentlemen:
Please send me a free copy of the R/M Vee-Flex bulletin.

Name_____

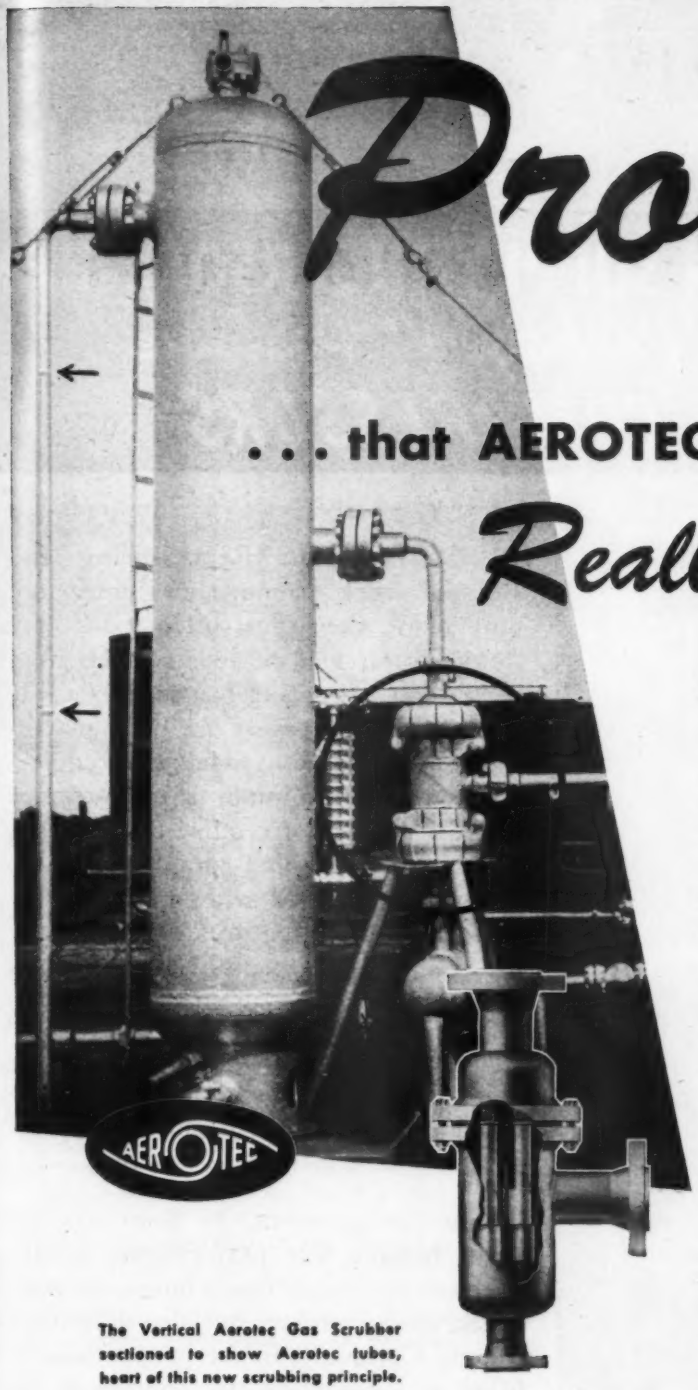
Position_____

Company_____

Address_____

City_____ Zone_____ State_____

RAYBESTOS-MANHATTAN, INC., Manufacturers of Packings • Asbestos Textiles • Mechanical Rubber Products • Abrasive and Diamond Wheels • Rubber Covered Equipment Brake Linings • Brake Blocks Clutch Facings • Fan Belts • Radiator Hose • Powdered Metal Products Bowling Balls



The Vertical Aerotec Gas Scrubber sectioned to show Aerotec tubes, heart of this new scrubbing principle.

Proof

. . . that AEROTEC GAS SCRUBBERS *Really* clean gas

This pilot installation at Alice, Texas, used on very dry gas, was first installed on the discharge of a conventional type gas scrubber (position of first installation shown by arrows). In 18 hours of operation, this Aerotec unit collected 2 quarts of liquid, from gas that had passed through the conventional unit.

Installed at the inlet to the conventional gas scrubber, only one teacup of fluid was collected from the conventional type in 8 days, and this was probably condensation.

This is a typical example of field reports on the high efficiency of Aerotec gas scrubber units. Based on a modification of the principle of separation used in dust collection, Aerotec units have produced outstanding results, both at the well and on pipeline applications.

A catalog on operating and application data will be sent on request. Just write our Project Engineers, or the field office nearest you.

Project and Sales Engineers

THE THERMIX CORPORATION

Greenwich, Connecticut

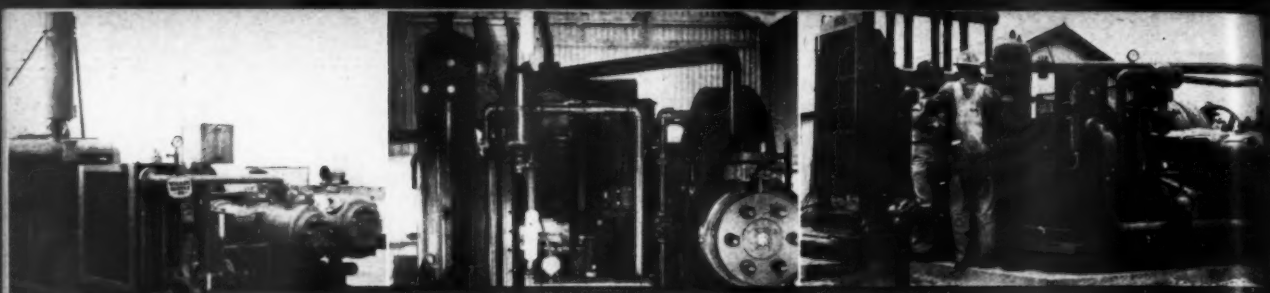
(Offices in 28 Principal Cities)

Canadian Affiliates: T. C. CHOWN, LTD., 1440 Saint Catherine St., W., Montreal 25, Quebec; 50 Abell St., Toronto 3, Ontario

THE AEROTEC CORPORATION

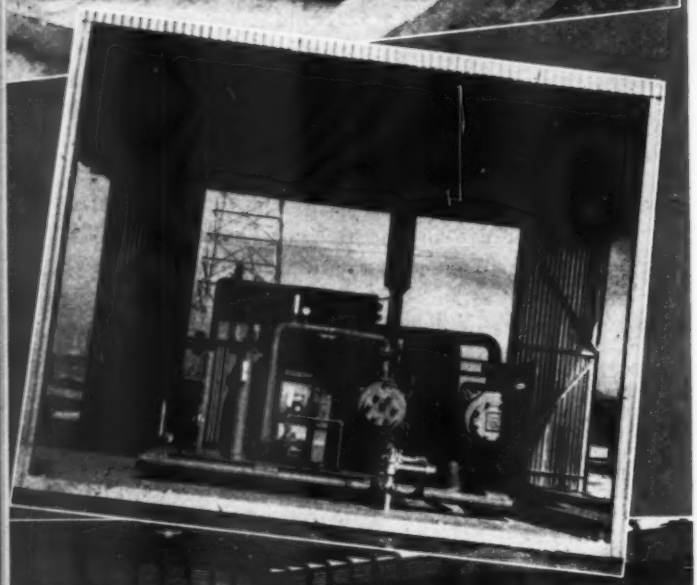
GREENWICH, CONN.

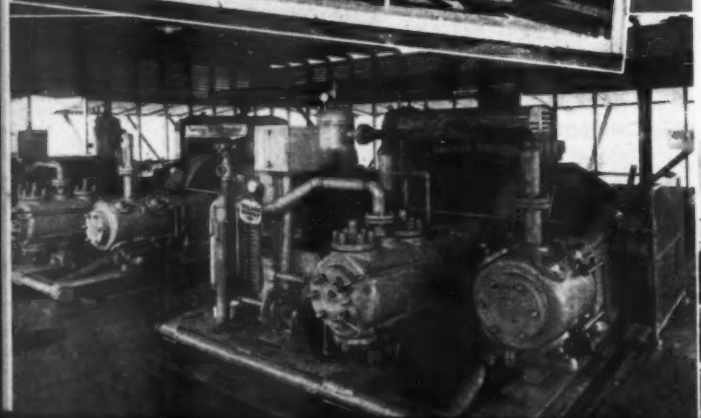
XUM



WILSON SUPPLY-INGERSOLL-RAN

"Packaged" Portable COMPRESSORS



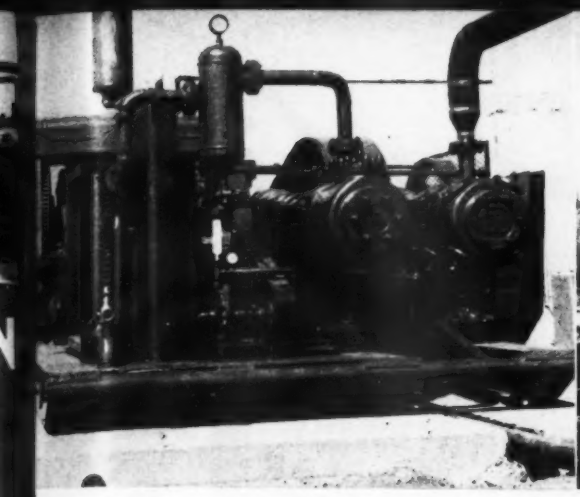


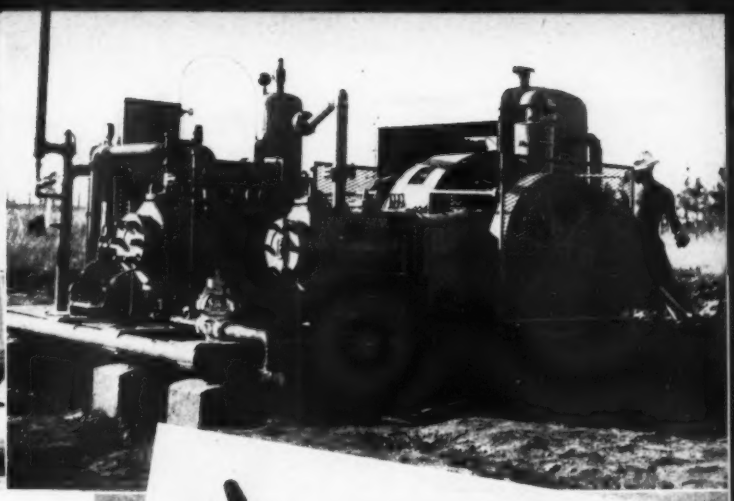
In Gas-Oil Lift, Repressuring and Booster work Compressors must not only work, they must often work continuously for long periods of time. Wilson Supply - Ingersoll-Rand "Packaged" Portable Compressors are built, assembled and mounted to meet such requirements with a minimum of maintenance costs. They do not require the constant attention of a skilled compressor man. They are equipped with many proven automatic safety features which protect the equipment in event of mishap when the attendant is not present.

Pictured on these two pages are a few of the many Wilson Supply - Ingersoll-Rand "Packaged" Portable Compressors now in the field.

These Compressors, by their continuous, trouble free performance testify to the engineering "know how", not only of the manufacturer, but also of Wilson Supply Company, in the proper assembling and mounting the equipment on heavy skids.

XUM





ROVEN DEPENDABLE
In the Field

These "Packaged" Portable Machines take the place of far more costly permanent installations and can be furnished in the size to best meet your specific requirements.

What are your needs? Check the sizes and specifications of the eight machines listed below and see if one of these Wilson Supply - Ingersoll-Rand "Packaged" Portable Compressors cannot save you money—

1. **6"x3¼"x7" — 50 H.P., 20-Lb. Suction, 500-Lb. Discharge, 235,000 Cu. Ft. Per Day.**
2. **8"x4¼"x9" — 75 H.P., 20-Lb. Suction, 600-Lb. Discharge, 402,000 Cu. Ft. Per Day.**
3. **8"x4⅛"x9" — 75 H.P., 20-Lb. Suction, 700-Lb. Discharge, 382,000 Cu. Ft. Per Day.**
4. **7"x4⅛"x9" — 80 H.P., 40-Lb. Suction, 600-Lb. Discharge, 547,000 Cu. Ft. Per Day.**
5. **9"x4¼"x9" — 80 H.P., 10-Lb. Suction, 500-Lb. Discharge, 405,000 Cu. Ft. Per Day.**
6. **4⅛"x9" — 45 H.P., 200-Lb. Suction, 600-Lb. Discharge, 630,000 Cu. Ft. Per Day.**
7. **3½"x11" — 85 H.P., 800-Lb. Suction, 1750-Lb. Discharge, 1,792,000 Cu. Ft. Per Day.**
8. **5¾"x13" — 117 H.P., 200-Lb. Suction, 700-Lb. Discharge, 1,600,000 Cu. Ft. Per Day.**

●

Contact your nearest Wilson Supply Company Store or write "Compressor Division," Wilson Supply Company, P. O. Drawer 19, Houston, Texas, for detailed information, and quotations. Please give suction and discharge pressure and volume to be handled.

WILSON SUPPLY COMPANY

BRANCH STORES: TEXAS—Alice, Corpus Christi, Victoria, Bay City, Columbus, Barbers Hill, Liberty, Beaumont, Kilgore, Monahans. LOUISIANA—Lake Charles, New Iberia, Houma, Harvey, Shreveport.

1412 Maury St.
HOUSTON
TEXAS

SALES OFFICES:
Tulsa, Okla., Dallas, Texas
New Orleans, La.

XUM

USE THESE BETTER

Vogt Products

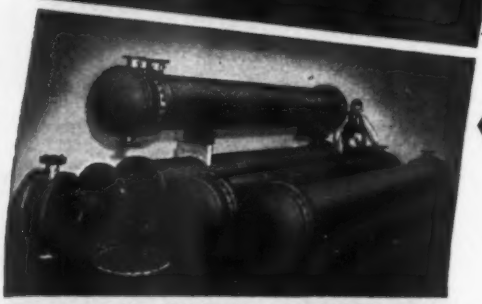
For Today's Tough Service Demands

EFFICIENT AND DEPENDABLE STEAM GENERATION

Vogt steam generating units are designed to give maximum rating in a minimum of space with high efficiency and low maintenance expense. Bent tube types and straight tube, forged steel sectional header types to burn solid, liquid or gaseous fuels, as desired, meet every power, heating or process requirement.

PROCESS EQUIPMENT FOR EVERY SERVICE

Stills, towers, oil chilling machines, filter presses, heat exchangers, etc. are constructed to all Codes. They meet all demands for operating security and trouble-free performance and help to lower costs in important process industries around the world.



SPECIAL MATERIALS FIGHT CORROSION AND PRODUCT CONTAMINATION

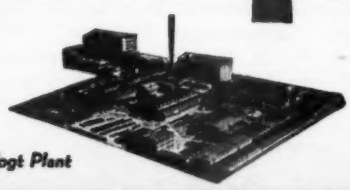
Our modern shops produce a wide variety of equipment made from special metals and alloys to combat corrosion, and product contamination or discoloration. Fabrication procedures employed insure that corrosion resistant properties of welds will match that of the materials from which units are constructed.

MORE TONNAGE AT LESS COST

Over 60 years of manufacturing experience, engineering and research stand behind Vogt refrigerating and ice making machinery. Absorption Systems, Compression Systems, and the Automatic Tube-Ice Machine in a wide range of capacities serve in leading petroleum refineries, chemical plants, ice and cold storage plants, dairies, packing plants, etc., at home and abroad.

DROP FORGED FOR EXTRA TOUGHNESS AND LONG-TIME SERVICE

Vogt valves, fittings and flanges, for top performance in oil, water, air, gas, and ammonia services, at high or low pressures and temperatures, are available drop forged entirely from carbon steel or stainless steel. Valves can be furnished in a combination of materials by using stainless steel for parts affected by service temperature or corrosion, and less expensive alloys or carbon steel for other parts.



Air View of Vogt Plant

HENRY VOGT MACHINE CO.

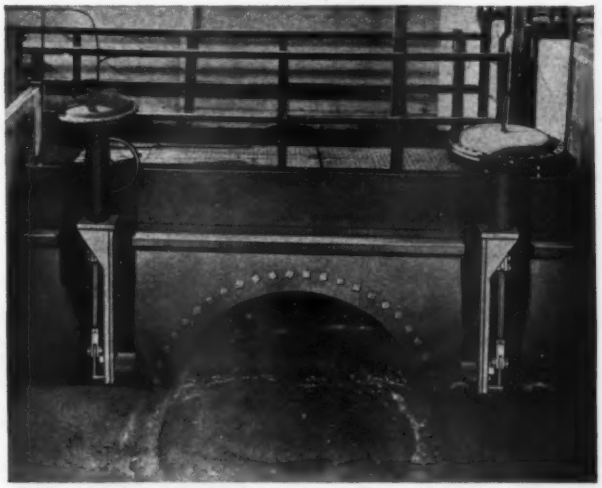
LOUISVILLE 10, KENTUCKY

BRANCH OFFICES NEW YORK PHILADELPHIA CLEVELAND CHICAGO ST LOUIS DALLAS

XUM

R-S valvEvents

• EXCERPTS FROM THE R-S BOOK OF EXPERIENCE •



AUTOMATIC CONTROL of Industrial Sewage

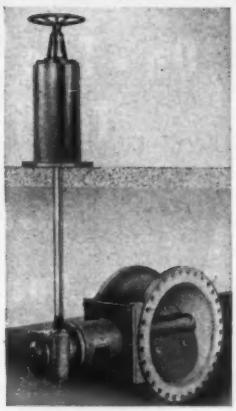
Photograph shows R-S 60-inch Valve discharging sewage from an oil refinery. The valve is operated by means of dual air diaphragm top works and stainless steel linkage, with a handwheel for emergency operation. By means of a level device, the valve is automatically closed at high tide thus eliminating the possibility of flooding the refinery. Valve opens automatically should the air pressure fail. Under emergency conditions or should all power fail, one man can close the valve with a few turns of the handwheel.

R-S Valves are used in air, gas, liquid, steam and semi-solid service in the pressure range from 2 to 2500 psig. They are available in sizes from 2-inches to 72-inches and larger for the simplified control and shut off of volume and pressure.

Consult with your local R-S Valve Engineers or write direct.

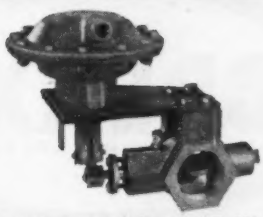
R-S PRODUCTS CORPORATION
4600 Germantown Avenue
Philadelphia 44, Pa.

No. 790—Eight-inch Steel Straight Through Slide Valve with pull lever control. Flange on left side when removed permits replacement of slide or cleaning of valve.



No. 788—Fifty-pound Heavy Duty Service Valve with rubber seat. Equipped with totally enclosed gear reduction drive, extended shaft and floor stand.

No. 769—Steel Off-center Relief Valve for low pressure drop. Hand lever can be used as an instrument lever. Counter weight on right side of valve. Relieves at 1 psi differential pressure.



No. 778—Two-inch Threaded End Valve complete with bracket and diaphragm top.

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Break your emulsions with BREAXIT

On • The • Spot Testing *and* To • Your • Lease Delivery

The BREAXITS are emulsion-breaking compounds specially adapted to each job on the job. A trained, field-service engineer tests live oil *on your lease* and determines the type and amount of BREAXIT to give you pipe line oil. The nearest BREAXIT distributor makes delivery to your *lease.*

BREAXIT
REGISTERED U. S. PAT. OFF.

is sold by . . .

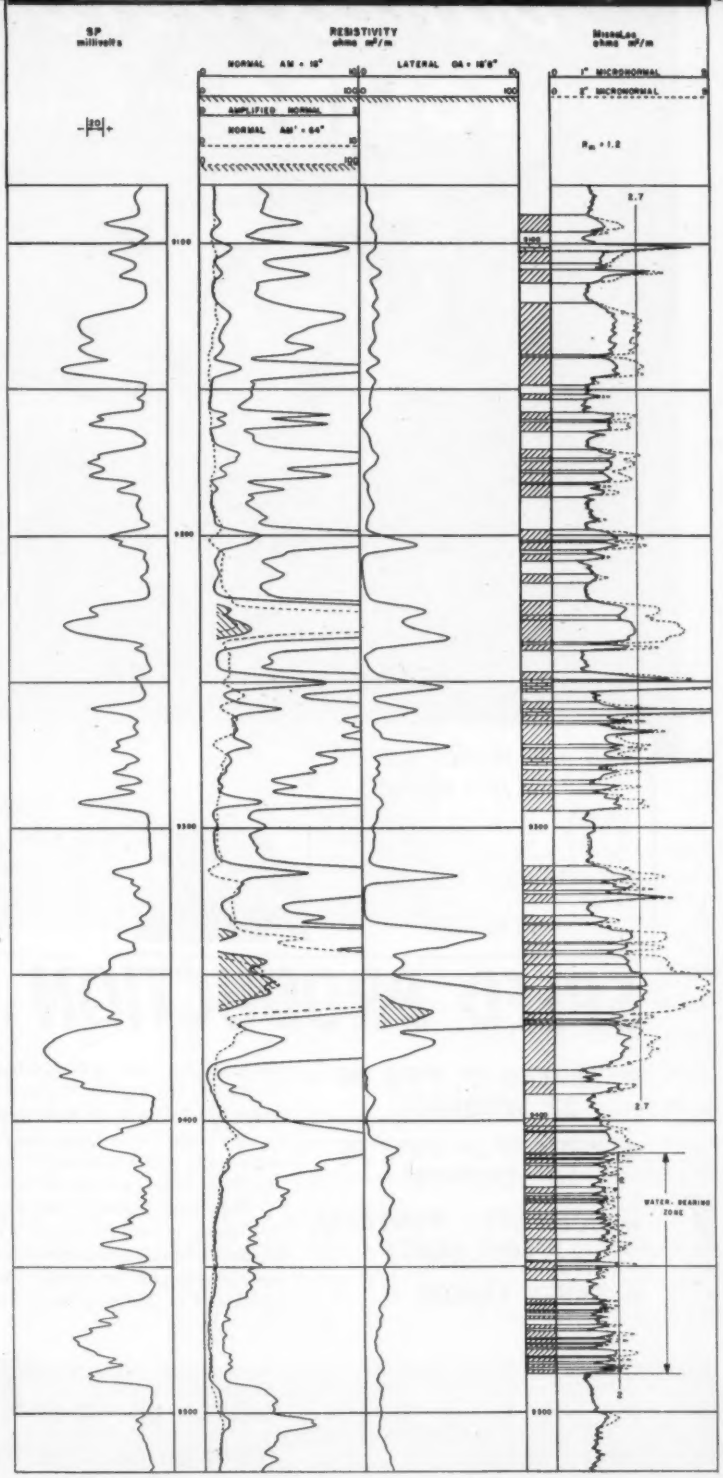
HUMBLE OIL & REFINING CO.
HOUSTON 1, TEXAS

THE MICROLOG* IN UNCONSOLIDATED FORMATIONS

FRIO SAND IN POINT COUPEE PARISH LOUISIANA

SCHLUMBERGER WELL SURVEYING CORPORATION
HOUSTON, TEXAS

Electrical Log



Mud (Caustic & Quebracho): $R_m = 1.5$ at B.H.T.
Bit Size: 9⅞"

Spacings:	Regular	"MicroLog"
	AM = 16"	Micronormal 1"
	AM' = 64"	Micronormal 2"
	AO = 18'8"	

The "MicroLog" is a record of resistivity measurements made with electrodes at short distances from one another applied to the wall of the bore hole. The influence of the mud column is practically eliminated by an insulated electrode support.

The "MicroLog" was developed for use in consolidated formations. It has proven to be an equally valuable tool for investigating unconsolidated sections. It provides a remarkably detailed record of the formations, in particular, of permeable porous strata with reservoir possibilities. It then permits a very accurate determination of the amount of pay section.

Three formation types with precise boundaries are illustrated. The regular electrical log complements the "MicroLog" in analyzing the types:

1) Shale—Indicated by low "MicroLog" values with a minimum of separation between the curves. Thin shale or sand laminations are further characterized by breaks in the microcurve.
2) Unconsolidated sand — Indicated by somewhat higher (than shale) "MicroLog" values, usually with a separation between curves. The longer micronormal value is normally the higher on permeable, porous strata.
3) Consolidated (Calcareous) sand streaks—Indicated by high "MicroLog" values. Such streaks should be eliminated in determining net pay.

The amount of separation between the curves depends on certain characteristics of the media and on bore hole conditions. Compare the section from 9410' to 9480' with the rest of the log. Conditions affecting the separation include:

1) Amount of shale in the sand and/or thickness of the sand-shale laminations.
2) Salt water versus oil sand. The curve with the longer spacing will normally show a higher value in oil sand because residual oil is present in the invaded zone.

The "MicroLog" confirmed sufficient section in this case to attempt a completion from 9289-93'.

PRODUCTION RESULTS:

Perforated:	9289 - 93'
Potential:	147 B.O.P.D.
Gas/oil Ratio:	497 - 1
Water:	30%

SCHLUMBERGER

SCHLUMBERGER WELL SURVEYING CORP.
HOUSTON

*"MicroLog" is a Trade Mark of the Schlumberger Well Surveying Corp.

XUM

NOW—YOUR CHOICE!

Wheel or Knife CUT-OFF

with **TOLEDO** 2" Portable Power Pipe Machine

"This new WHEEL Cut-Off is a honey!"

It's a cinch to use. Cutter head equipped with two rollers and one cutter wheel which is self-centering and easily fed with hand wheel. Cuts off pipe rapidly. Extremely simple in design with few moving parts. Simple adjustment.

"I like the KNIFE! Been using it for years!"

With the Toledo Knife Cut-Off, four cutter knives leave a straight square-end cut without burr. Blades are fed thru a scroll by a small hand wheel. May be resharpened many times.

SPEED PRODUCTION... CUT COSTS!

★ **THREAD 2" PIPE IN 22 SECONDS!**

★ **CUT OFF 2" PIPE IN 10 SECONDS!**

★ **COMPACT...PORTABLE ...LOW COST!**

★ **SAVES LABOR!**

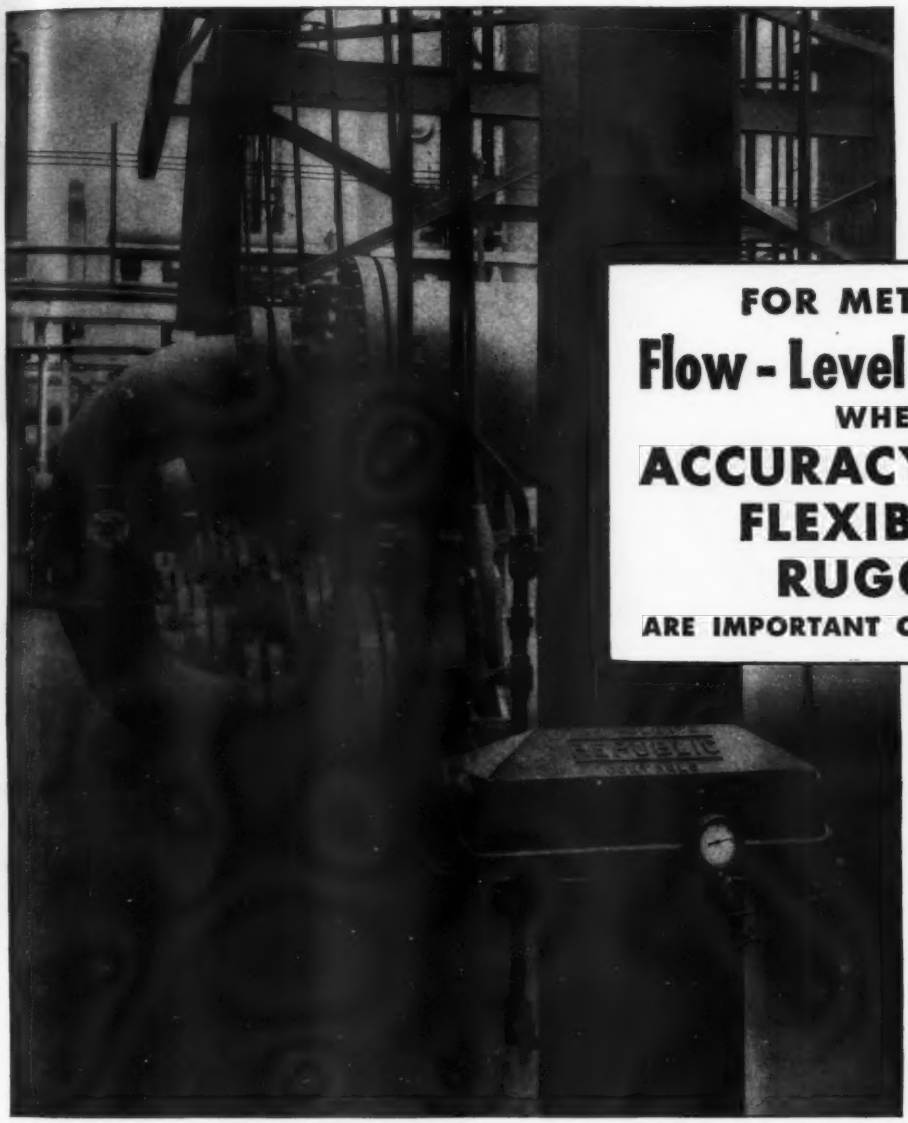
Today more than ever you need the speed and practical features of this great TOLEDO No. 999 2" Power Pipe Machine! Gives you high production—reduces costs—saves up to 80% on pipe threading time compared with hand methods!

It's "tops" with better mechanics for cutting, threading and reaming all pipe sizes up to and including 2" and bolts from ⅜" to 1½". Popular and efficient for shop or job use or for industrial plants.

Now—the Super Model available with choice of Wheel or Knife Cut-Off. See it—try it—with the new Wheel and Roller Cut-Off! Outstanding for simple design... quick adjustment... rapid cut-off. Toledo-built dependability. Ask your distributor for details. Write for bulletin. The Toledo Pipe Threading Machine Co., Toledo, Ohio. New York Office: 165 Broadway, Room 1310.

RELY ON THE LEADER **TOLEDO**

POWER DRIVES...PIPE TOOLS...POWER PIPE MACHINES



FOR METERING

Flow - Level - Pressure

WHERE

ACCURACY
FLEXIBILITY
RUGGEDNESS

ARE IMPORTANT CONSIDERATIONS

One of a group of Republic transmitters metering flow and level in a modern chemical processing plant.

Republic Pneumatic Transmitters are available for measuring flow, liquid level, pressure or liquid density of a wide range of fluids. They employ the force-balance principle to convert these process variables into air pressures which vary proportionally. These air pressures become direct measurements and can be conducted to reading instruments or used as the measuring impulse for the actuation of an automatic controller.

Republic transmitters have a guaranteed accuracy of within 1/2 of 1% of the transmitter range. By making a few minor adjustments or substituting a few small parts, their operation can be easily changed to any desired range between a minimum of 0-0.6" to a maximum of 0-704" of water. Their construction is more like that of a precision machine than of the sensitive instrument they are. Data Book No. 1001 contains complete details — write for your copy.

REPUBLIC FLOW METERS CO.

2240 Diversey Parkway, Chicago 47, Illinois

XUM

OUR NAME!

Every product known to science for the preparation and treatment of drilling muds to meet specific conditions . . . extensive laboratory and research facilities, manufacturing facilities for preparing special drilling mud materials, capable field engineers to assist at the rig, and more than 250 Magcobar Dealers to meet your needs night and day . . . all combine to make up Magcobar's complete drilling mud service. Look for the Magcobar sign when you need mud. It's your guarantee of quality products and prompt service.

MAGNET COVE BARIUM CORPORATION

ONE OF THE DRESSER INDUSTRIES

MALVERN, ARKANSAS • HOUSTON, TEXAS

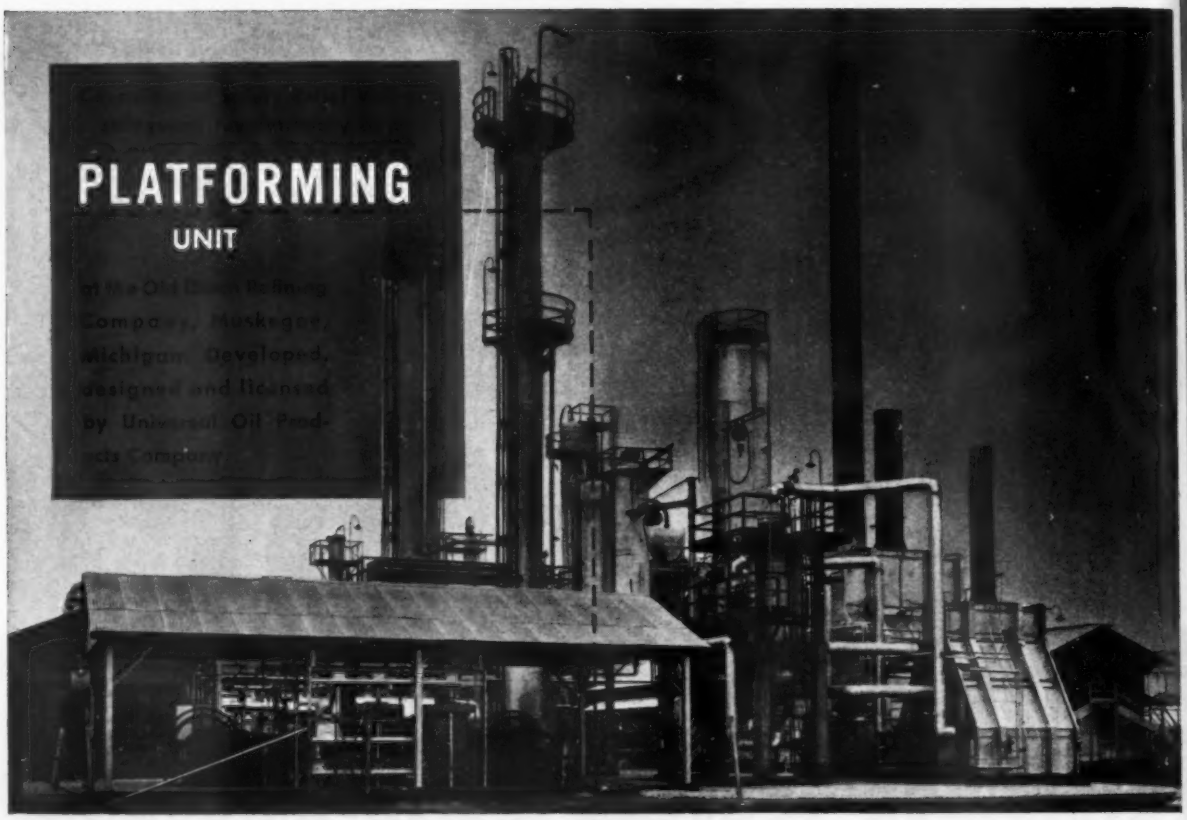
IS MUD!

Magcobar

Complete

DRILLING MUD SERVICE

XUM



An "OPEN SECRET" on SAFETY

Dependable tightness . . . the industry's invariable valve safety standard . . . here called for valves that consistently hold material running as high as 90% hydrogen, and in the particular instance of the reaction chamber, function precisely under approximately 900 PSI set pressure at 1000° F.

Consolidated Safety Relief Valves were selected to do the job. For Consolidated outside bevel seat and floating guide construction positively eliminates leakage under *discharge piping stresses*. Only Consolidated Safety Relief Valves have that all-important and exclusive extra safeguard of *built-in fixed capacity* . . . independent at all times of the position of multiple adjustable blow-down rings. One adjustment controls blow-down . . . cannot be altered accidentally during maintenance . . . lift or secondary annual orifice area is not disturbed.

This is one of the many Consolidated Safety Relief Valves installed throughout the new Platforming Unit of the Old Dutch Refining Company.

The basically simple design (25% of the parts used in ordinary safety valves are eliminated), assures much lower maintenance costs and also minimizes standardization problems.

These "open secrets" of Consolidated design and construction are the key to safety . . . as well as simple economical, long-time operation however severe valve service conditions may be.

See your local distributor for complete information

CONSOLIDATED SAFETY RELIEF VALVES

A Product of

MANNING, MAXWELL & MOORE, INC.
TULSA, OKLAHOMA

Makers of 'Consolidated' Safety and Relief Valves, 'American' Industrial and 'Microsen' Electrical Instruments, 'Hancock' Valves, 'Ashcroft' Gauges. Builders of 'Shaw-Box' Cranes, 'Budgit' and 'Load Lifter' Hoists, and other lifting specialties.

QUICK ACCEPTANCE *in the gas transmission field!*

Pipe line companies purchase over 60 Worthington uniflo design TYPE UTC-16 angle gas engine compressors

It takes time — and actual working conditions — to show how equipment stands up. That explains the keen interest of transmission companies and refineries when the first commercial installation of Worthington's new Angle Gas Engine Compressor TYPE UTC-16, was dismantled for inspection. After 2763 hours of continuous operation — under full load and frequent overload — it was found that:

- **All parts were carbon-free,** demonstrating the marked superiority of Worthington uniflo scavenging over conventional loop scavenging for reducing wear.
- **Pistons and liners were still well within shop tolerances,** and the high polish on the entire liner surfaces indicated A-1 operating condition.
- Rings showed minimum wear, with tool marks still visible.
- Bearings were all in perfect condition.

A Success From The Start

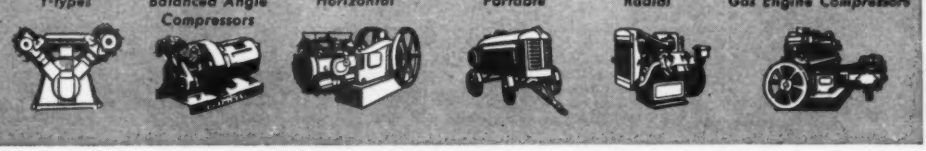
Shop tests had already proved TYPE UTC-16's more thorough scavenging, and perfect combustion. Now, this far more conclusive field test proved the ability to assure these benefits over a long, trouble-free service life. And a steadily growing list of purchasers has established TYPE UTC-16 as a real history-maker in the development of more efficient, more economical gas transmission.

Why not investigate the many advantages of joining this list? Get the whole story that proves *there's more worth in Worthington* from our nearest District Office. Or write to *Worthington Pump and Machinery Corporation, Engine Division, Buffalo, N. Y.*

WORTHINGTON

EK-6-3

NO OTHER COMPRESSOR WILL OUTPERFORM A WORTHINGTON



A TIMELY SUBJECT—the benefits of the free enterprise system—is covered in terms which we know best: the story of Standard Oil. This is the eighth advertisement in the company's 1950 institutional campaign.

BEING BORN IN THE UNITED STATES is one of the luckiest things that can happen to anyone, for it gives a person the opportunity to prosper under the American system. God made our country rich; our system of free competitive effort has made it richer. There are many stories that help explain how this was done. Here's the one we know best: the story of Standard Oil and its subsidiary companies.

WHY IT PAYS TO BE BORN IN AMERICA

A. L. CHILDERS now receives monthly retirement checks after years of service at our Sugar Creek, Missouri, refinery. He started with us at less than $1,500 a year in 1915, when there was one automobile for every twenty today. Employee benefits were rare throughout industry, and most people were accustomed to a work week nearly 50 hours long.

TODAY, IT'S DIFFERENT, with 46,700 Standard Oil employees averaging $4,600 last year in wages and benefits. One of them is L. J. Willy of our Casper, Wyoming, refinery. He and his family are protected by one of the finest, broadest employee benefit programs in any industry. His work week is 40 hours, and working conditions are the best ever.

ONE BIG REASON why Mr. Willy is so much better off is that he has behind him an average investment of $30,100 in tools and equipment. Like every Standard Oil employee today, because he has better tools, he can produce far more than the employees of Mr. Childers' day ever could. And high productivity is the foundation of a high standard of living.

WHERE DID WE get the money to pay for our tools and equipment? It is the result of the investment of the 96,800 owners of Standard Oil. Miss Edith Bastian of Redfield, S. D., is one of them. In 1949, our 56th consecutive year of dividend payments, stockholders were paid dividends having a value of $2.69 per share—a return on money that helped provide jobs and made increased production possible.

W. B. ("BUD") LEAMER of Topeka, Kansas, is one of the thousands of independent businessmen who sell Standard Oil products. His modern service station is a far cry from the livery stable of his grandfather's day. Many thousands of livery stable jobs have disappeared—but millions of new jobs and higher living standards have been created by the automobile and petroleum industries.

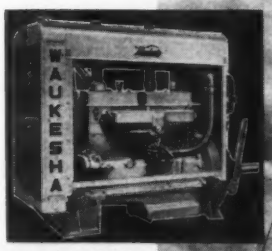
FRANCES WILLMAN of St. Joseph, Missouri, is one of Standard Oil's customers. People buy our products because they like our quality and our values—and we hope, because they like us. Our 46,700 employees work together as an integrated team to make more products more economically, to make them more readily available—and thereby, to continue to deserve your confidence.

STANDARD OIL COMPANY (INDIANA)

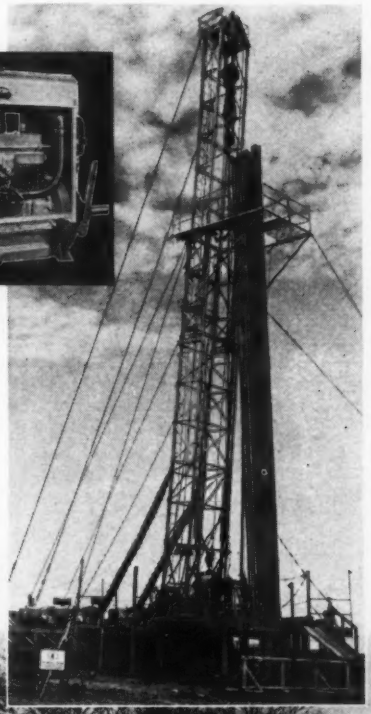
Drilling at 3700 ft. with 3¼ in. pipe near Newcastle, Wyo., this Cardwell Trailerig has twin Waukesha 6-WAKU power units. Owner, B. F. Allison Drilling Co., Graham, Texas.

POWER plus PORTABILITY

The *Cardwell* TRAILERIG is modern, complete, compact! entirely self-contained! portability plus! Recommended by its makers for drilling to 5000 ft. with 4½ in. drill pipe and workover jobs to 10,000 ft. Equipped with 90 ft. telescoping mast and mud pump drive. Double drum drawworks has twin Waukesha 6-WAKU Power Units, each one putting out better than 200 hp. at the peaks. Air disc clutches in both ends of drum provide high and low drum speeds operated by single lever. All necessary hoisting, mud pump and table speeds available simultaneously. Waukesha Super-Duty Sixes for dependable drilling. Get Bulletin 1139.



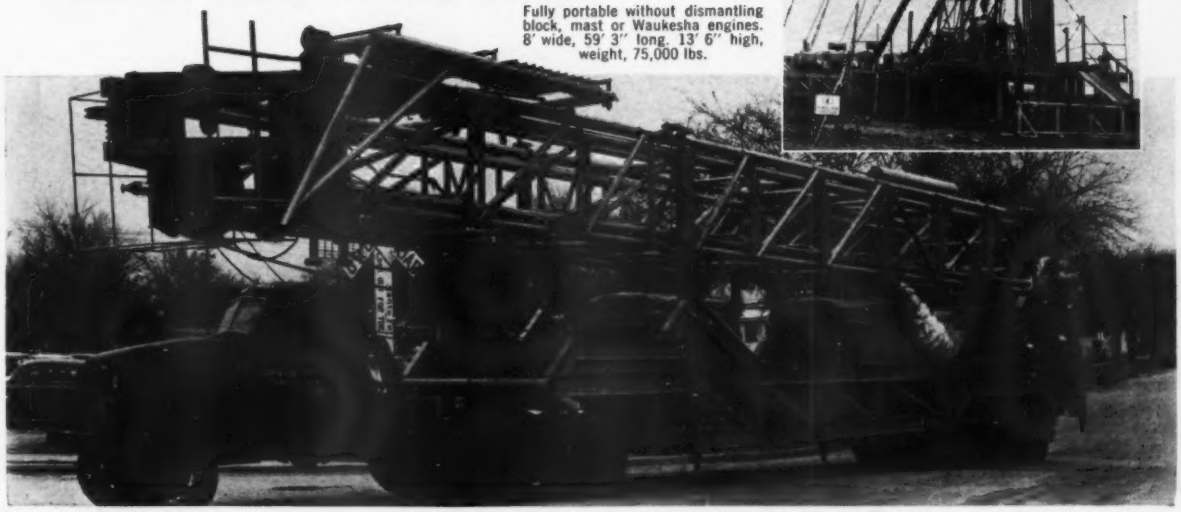
Model 6-WAKU POWER UNIT
six cyl. 6¼ in. x 6½ in., 1197 cu. in., 213 hp. max. at 1300 rpm., burns gas or gasoline.



WAUKESHA MOTOR COMPANY, WAUKESHA, WIS.
NEW YORK • TULSA • LOS ANGELES

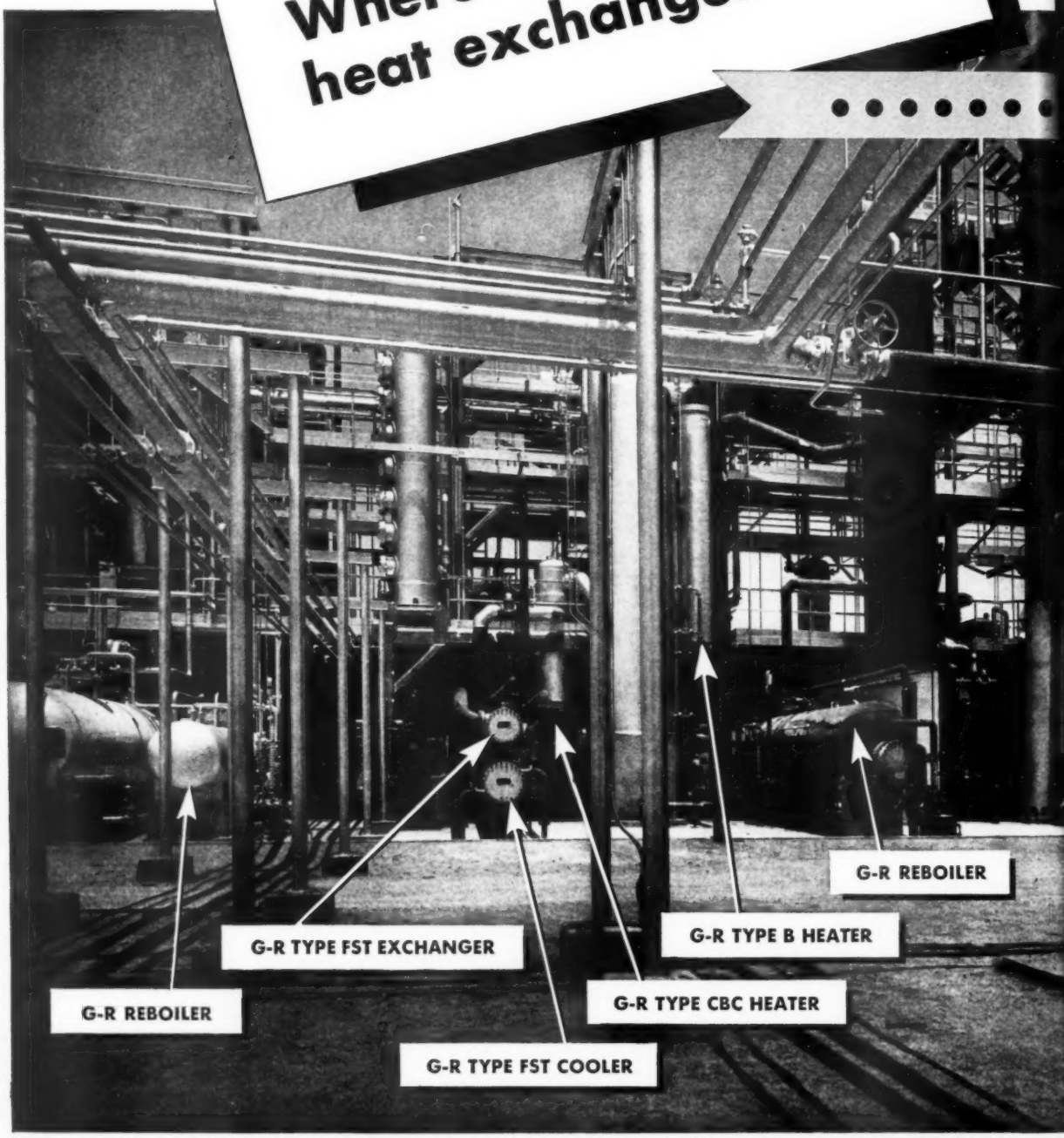
WAUKESHA

Fully portable without dismantling block, mast or Waukesha engines. 8′ wide, 59′ 3″ long. 13′ 6″ high, weight, 75,000 lbs.



XUM

Wherever you see a heat exchanger here



GRISCOM-RUSSELL • PIONEERS IN HEAT TRANSFER APPARATUS

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XUM

..it's a G-R unit

This Badger-built plant is a model of top-notch engineering and construction. To help make it so, G-R Exchangers, Coolers, Heaters and Reboilers are used, because of the proven excellence of G-R Heat Transfer Apparatus.

Here, as in other petroleum refining and chemical process plants all over the world, G-R Heat Transfer apparatus was selected to assure maximum effectiveness at minimum operating and maintenance cost.

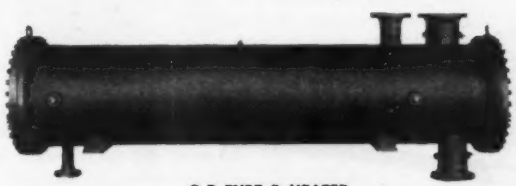
G-R designs include bare tube and finned tube units for every heat transfer requirement, based on our unequalled specialized experience of more than 80 years. Each G-R unit has many exclusive and distinctive features which have been developed through continuous pioneering and which are unobtainable in other designs.

Write for bulletins describing heat transfer units in which you are interested, and be sure to consult the G-R engineers for your particular needs.

THE GRISCOM-RUSSELL CO.
285 MADISON AVE., NEW YORK 17, N. Y.

G-R TUBULAR EXCHANGER
A shell-and-tube unit with many distinctive features for efficient performance with minimum attendance and maintenance expense.

G-R REBOILER
Widely used in process industries, and available with either bare tubes or K-Fin helically finned elements.



G-R TYPE B HEATER
A simple, practical design, highly efficient on moderate pressure, moderate temperature duties.

GRISCOM-RUSSELL

GR-351

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Bingham

PRECISION BUILT FIELD PROVEN PUMPS

"Double Volute"
DOUBLE CASE, HIGH PRESSURE
Refinery Pumps

Bingham Double Case Refinery Pumps are of "Double-Volute" design, insuring perfect radial balance of the rotating element — eliminating seizure and wear between rotating and stationary parts and reducing stuffing-box maintenance to a minimum.

A salient feature in Bingham "Double-Volute" pumps is the "TWO NOZZLE" discharge from the inner case into the outer case—the nozzles being located 180° apart. For hot service, this feature provides adequate circulation of pumpage, insuring a uniform temperature rise of all parts, particularly the outer case. *Distortion due to temperature changes is eliminated.*

• • •

It takes Big Precision Tools like these to Build Pumps like this

Bingham Double Case Pumps, like all Bingham products, are precision built in our new and modern plant. All rotating parts are dynamically balanced. All parts requiring close tolerances are ground on heavy duty pre-precision grinders. Each part is subjected to rigid inspection by craftsmen who for years have been trained to follow Bingham's high standards of manufacture.

Bingham Double Case, "Double-Volute" High Pressure Hot Oil Heater Charge Pump operating in a large Mid-Continent refinery.

Heavy Duty Face Grinder in our new and modern plant.

SEND NOW FOR "DOUBLE VOLUTE" treatise describing the principle and advantages of Bingham "Double Volute" pumps.

Bingham

DOUBLE VOLUTE RADIAL BALANCE

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Portland, Oregon

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FIELD WELDS UNIFORMLY

Expanded STEEL PIPE

by WORTH

Yes, Worth Steel Pipe welds uniformly because the "Fully Deoxidized" Steel Plate used in its manufacture is carefully controlled and produced entirely within our own plant under the supervision of skilled craftsmen. This painstaking control not only enables you to weld Worth Pipe easier but it makes it easier to bend.

To save valuable time in "fitting-up" and "laying-down" your line pipe, specify Worth—a product of more than three generations of steel-making. Available in 22" to 36" O.D. Write for detailed information.

WORTH STEEL COMPANY • Claymont, Delaware

FLANGED AND DISHED HEADS • CARBON AND STAINLESS-CLAD STEEL PLATES

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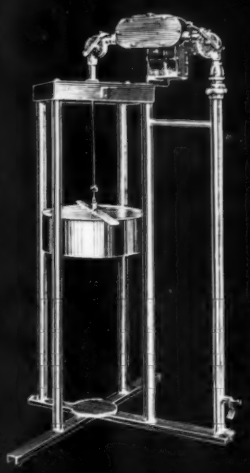
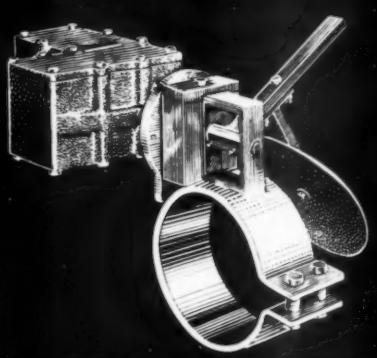
KNOCKOUT BLOWOUTS

with the NEW S&J Mud Flow Measuring System!

A well blowout always telegraphs its coming via changes in the mud flow cycle . . . sometimes minutes, often hours BEFORE it arrives. To receive and interpret this all-important warning a driller must have a thorough knowledge of mud flow characteristics, and he must have the proper instruments which will supply him with pertinent information, quickly and accurately. Now, Shand & Jurs has just the instruments to answer this purpose. S&J's new mud flow measuring system is composed of the four units shown here. They are interconnected ELECTRICALLY . . . the most accurate and dependable means of transmitting signals from one point to another. Every part of this mud flow measuring system is designed and constructed with the same high quality and careful precision as the other equipment Shand & Jurs supplies to the petroleum industry. Contact the factory, or any of the branches below for further information about this new S&J mud flow measuring system.

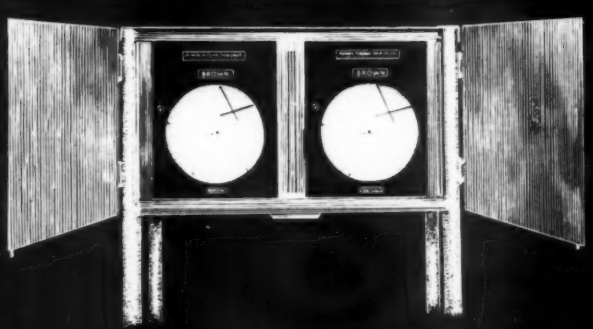


The S&J Mud Pit Level Gauge. Located in the mud pit this sturdy, non-tippable, tubular steel frame supports the transmitting mechanism and heavy duty steel float which is partially counterbalanced.



The S&J Mud Flow Indicator. Mounted over the end of the mud return outflow pipe, the counterbalanced gate measures and transmits changes in the mud flow rate.

The S&J Visual Indicator and Alarm. Mounted on the drilling floor at easy-to-read eye level, it shows at a glance the mud pit level and rate of mud return.



The S&J Mud Flow and Mud Level Recorder. Located away from the rig, free of vibration, this instrument keeps a permanent record of all changes in mud pit level and rate of mud return flow. Driller or relieving crew can refer to these records and note any trend which might indicate the possibility of a well blowout.

Shand and Jurs Co. 917 CARLETON STREET · BERKELEY · CALIFORNIA

NEW YORK 296 Madison Ave. CHICAGO 332 So. Michigan Ave. HOUSTON 814 M & M Bldg. TULSA 310 Thompson Bldg. LOS ANGELES 714 W. Olympic Blvd. SEATTLE 3000 Western Ave.

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They Say—

The Atmosphere That Lures

"Like most people who engage in highly risky business, oil men are very sensitive to circumstances that affect their enterprise and with them, as with all of us, nothing succeeds like success. Some people say that there was a slight cooling in ardour among the Alberta oil seekers a little while ago because a considerable period has elapsed without a new discovery. If that is so the recent discoveries at Acheson, Flint, and Big Valley are doubtless raising the temperature again, perhaps to a higher degree than ever before.

"One factor which has been of major importance in attracting the hundreds of millions of dollars of risk capital which have poured into Alberta has been, of course, the emphasis on the policy of free enterprise. This has been appropriately stressed on numerous occasions and it has given to the risker the assurance that he will get a run for his money; a sense of security because he knows that if success does crown his efforts he will enjoy an appropriate reward. This is the atmosphere that lures the oil seeker and encourages him to venture such large sums on exploration."

G. L. Stewart, president of Imperial Oil, Ltd., speaking to the Canadian Club in Calgary.

"Last Derrick Legs"

"As strange as it may seem, the American oil industry, which has been reported in the words of one writer as 'on its last derrick legs since its birth in 1859,' actually is in a pretty healthy state at the present moment. In 1919 the chief geologist of the U. S. Geological Survey estimated our total reserves at 7 billion barrels, and stated that we would run out of oil in 15 years at the then current rate of production. Thirty years later, upon reviewing the figures, it is shown that since the prophecy was made we have discovered 56 billion barrels of new reserves, produced 34 billion barrels of oil, and have the largest proven reserves in our history.

"It has been estimated that in 20 years our population will grow to about 164 million, with an indicated petroleum demand of 25 to 30 bbl. per capita against a per capita demand today of about 16 bbl. Therefore, it would appear that you are not making a mistake in developing new reserves and having them in readiness. Such production, ready to go, would also be available in the

CATAWISSA
DOUBLE UNION SWING CHECK VALVE
"502"

FULL OPENING FOR 100% UNOBSTRUCTED FLOW!

COMPACT!
EFFICIENT!
ECONOMICAL!
EASILY ACCESSIBLE!

flow line and pipe line type for general oil country use in either horizontal or vertical position!

CATAWISSA Double Union Swing Check Valves are designed and recommended for rough and ready demands of oil country applications — for use in lines where no stop is installed close to the check valve and where pipe cleaning mechanisms (go-devils) are used. They are FULL OPENING, furnished with Catawissa PERFECT SEAL Unions on both ends, eliminating the use of a full union and nipple necessary to install regular type check valves! Can be easily cleaned or repaired on the line — with check holding line contents!

REFAX METAL BODIES
NITENSILOY WORKING PARTS
★
500-lbs. SERVICE O.W.G.
1500-lbs. TEST
250-psi WSP
★
SIZES 2" to 4"

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OIL WELL SUPPLY CO.
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WRITE FOR FREE CATALOG 11 SHOWING THE COMPLETE CATAWISSA LINE

CATAWISSA VALVE & FITTINGS COMPANY
450 MILL STREET ★ CATAWISSA, PENNA.

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TOPS IN THE FIELD!

LESS COST PER FOOT

Faster Penetration
Greater Footage Per Bit
Less Round-Trips

OUTSTANDING ENGINEERING RESEARCH

Diamond Bits, Washover Shoes, Reamers, Core Barrels, Handling Equipment. Drilling Technique —Field Service.

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LESS COST PER FOOT CHRISTENSEN DIAMOND PRODUCTS

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Export Representative: R. J. Eiche & Associates, Inc. Los Angeles - New York City

Canadian Representative: James Emrick Company, Ltd. Edmonton, Alberta

event of an emergency. Petroleum requirements, in the event of an emergency, undoubtedly would reach unprecedented levels."

Lieut. Gen. LeRoy Lutes speaking to the directors of the Texas Independent Producers and Royalty Owners Association in San Antonio.

Two Million Answers

"More than 900,000 hours of time, or 450 man-years, will be required to answer a preliminary set of questions posed against Standard Oil Co. of California in the pending West Coast petroleum antitrust suit. Some 2,000,000 answers are called for in this series of questions asked of Standard by the antitrust division of the Department of Justice.

"Now that South Korea has been secured we can stop and take a breath. But we're not going to let our guard down again. And in maintaining a sizable military force, ready to fight, we are going to be fighting a battle of production here at home.

"We can't be expected to do this job well—and it has got to be done perfectly—if we are forced to expend our energies and time battling an antitrust suit as far-reaching as the one which faces us now. One battle at a time is all we can successfully handle, and I leave it to you to judge which one it should be."

T. S. Petersen, president, Standard Oil Co. of California, speaking to the San Diego Chamber of Commerce.

CALENDAR

November

South Texas Geological Society, seventeenth annual fall meeting and field trip to Monterrey, Mexico; headquarters, Cucaracha Club, Reynosa, Mexico, November 16-19.

Petroleum Electric Power Association. Twenty-second Anniversary meeting, Arlington Hotel, Hot Springs, Ark., November 27-28.

American Society of Mechanical Engineers, annual meeting, Hotel Statler, New York City, November 26-December 1.

Rocky Mountain Oil and Gas Association annual meeting, Denver, November 30-December 1.

Southwestern Geophysical and Geological Conference, Hotel Texas, Fort Worth, November 30-December 2.

December

American Institute of Mining and Metallurgical Engineers, annual joint meeting Texas sections, Texas Technological College Lubbock, Tex., December 1-2.

American Institute of Chemical Engineers, annual meeting, Columbus, Ohio December 3-5.

New York Oil Heating Association, Hotel Statler, New York City, December 4.

Oil Industry TBA Group, 1950 meeting Edgewater Beach Hotel, Chicago, December 4-5.

New Mexico Oil and Gas Association, annual meeting, La Fonda Hotel, Santa Fe December 6.

Natural Gasoline Association of America Herring Hotel, Amarillo, December 8.

Interstate Oil Compact Commission, winter meeting, Shamrock Hotel, Houston. December 11-13.

1951

January

American Gas Association, home-service

workshop, Hotel Statler, Washington, D C., January 3-5.

Kansas Oil Men's Association, annual convention, Lassen Hotel, Wichita, January 8-9.

Society of Automotive Engineers, annual meeting and engineering display, Hotel Book-Cadillac, Detroit, January 8-12.

American Institute of Electrical Engineers, Tulsa Section, meeting on explosion-proof motors, Michaelis Cafeteria, January 11.

Southwestern Legal Foundation, second annual institute on oil and gas law and taxation, Southwestern Legal Center, Dallas, January 18-20.

Compressed Gas Association, annual meeting, Waldorf-Astoria Hotel, New York City, January 22-23.

Northwest Petroleum Association, annual convention, Nicollet Hotel, Minneapolis, January 25-26.

Southern Gas Association, employe-relations section and accident-prevention round tables, Mobile, Ala., January 26.

Instrument Society of America, New York section, Hotel New Yorker, New York City, January 26-27.

February

American Institute of Electrical Engineers, Tulsa Section, meeting on explosion-proof electrical equipment, Michaelis Cafeteria, February 8.

American Institute of Mining and Metallurgical Engineers, annual meeting, Jefferson and Statler hotels, St. Louis, February 19-22.

Kentucky Petroleum Marketers Association, annual meeting and trade show, Brown Hotel, Louisville, February 20-21.

Iowa Independent Oil Jobbers' Association, Inc., annual convention, Hotel Fort Des Moines, Des Moines, February 21-22.

Wisconsin Petroleum Association, annual convention and equipment show, Milwaukee Auditorium, Milwaukee, February 27-28.

March

American Society for Testing Materials, spring meeting and committee week, Cincinnati, March 5-9.

American Petroleum Institute, division of production, southwestern district meeting, Hotel Beaumont, Beaumont, Tex., March 7-9.

Indiana Independent Petroleum Association, spring convention and refiners and suppliers exhibit, Hotel Severin, Indianapolis, March 8-9.

Mid-West Gas Association, Hotel Fontenelle, Omaha, March 12-14.

Illinois Petroleum Marketers Association, annual convention, Sherman Hotel, Chicago, March 13-15.

National Association of Corrosion Engineers, annual conference and exhibition, Statler Hotel, New York City, March 13-17.

Gas Appliance Manufacturers Association, annual meeting, The Homestead, Hot Springs, Va., March 19-21.

Ohio Petroleum Marketers Association, annual convention and marketing exposition, Deshler-Wallick Hotel, Columbus, Ohio, March 20-22.

American Petroleum Institute, division of production, Mid-Continent district spring meeting, Herring Hotel, Amarillo, March 21-23.

Texas Independent Producers and Royalty Owners Association, fifth annual meeting, Beaumont, Tex., March 27-28.

New England Gas Association, annual meeting, Hotel Statler, Boston, March 29-30.

April

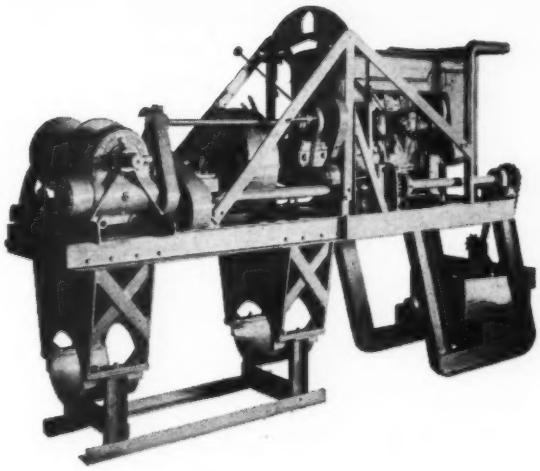
American Gas Association, industrial and commercial gas section, conference on industrial and commercial gas, Shoreham Hotel, Washington, D. C., April 2-4.

American Society of Mechanical Engineers, spring meeting, Atlanta, April 2-5.

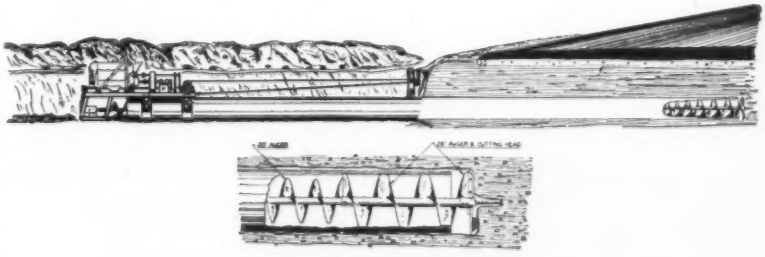
Instrument Society of America, New Jersey section, Essex House, Newark, N. J., April 3.

American Petroleum Institute, division of production, Eastern district meeting, Deshler-Wallick Hotel, Columbus, Ohio, April 3-5.

Mid-West Regional Gas Sales Conference,



CROSE AUGER TYPE ROAD BORING MACHINE installs pipe casing up to and including 34" in diameter. This machine has proven highly satisfactory with Pipe Line Contractors for the fastest method of installing pipe casing where rock is not encountered. Machines for installing casing larger than 34" in diameter are also available.



M. J. CROSE
MANUFACTURING COMPANY, INC.
2715 Dawson Road TULSA, OKLA. Phone 6-2173

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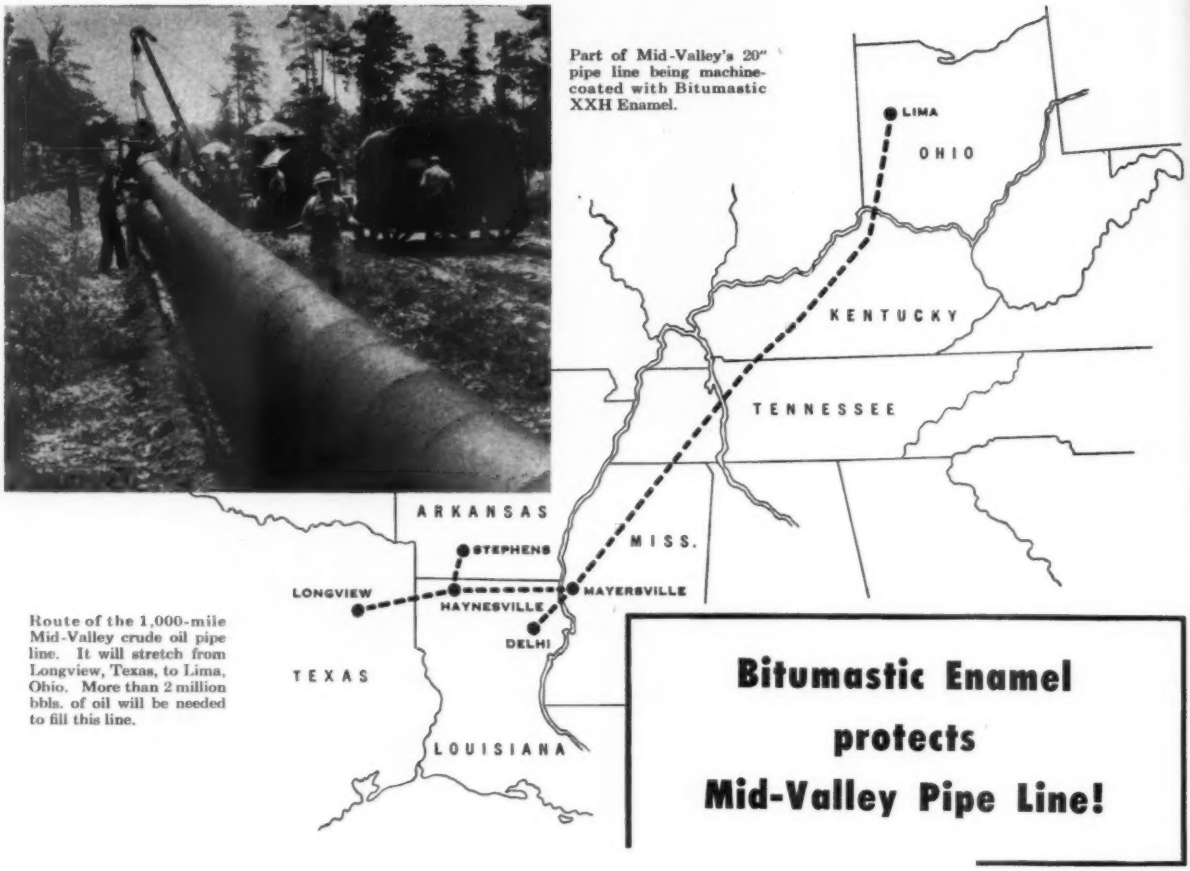
Part of Mid-Valley's 20" pipe line being machine-coated with Bitumastic XXH Enamel.



Route of the 1,000-mile Mid-Valley crude oil pipe line. It will stretch from Longview, Texas, to Lima, Ohio. More than 2 million bbls. of oil will be needed to fill this line.

Bitumastic Enamel protects Mid-Valley Pipe Line!

...ONE OF THE COUNTRY'S LARGEST AND LONGEST INTERSTATE COMMON CARRIER CRUDE LINES

THE Mid-Valley Pipe Line, that will stretch from Longview, Texas, to Lima, Ohio, will be an outstanding example of the engineering skill and ingenuity of pipeliners. Along the thousand-mile route, swamps, lakes and rivers, including the Ohio and the Mississippi, had to be "ditched" . . . rocky hills had to be crossed . . . forests had to be penetrated.

When pipe lines are laid under such rugged conditions, they *must* go down to stay . . . they *must* be fully protected against corrosion. And Koppers Coatings provide that protection.

Koppers Bitumastic® XXH Enamel was used to coat the line from Texas to Tennessee. In addition, three gathering lines have been protected by Bitumastic XXH Enamel.

Give *your* pipe lines the same effective protection by specifying "Koppers Bitumastic Enamel." Your Koppers representative will give you full details. Get in touch with him.

Why Bitumastic Enamels give lasting protection

Processed from a base of coal-tar pitch, they are impervious to moisture . . . chemically resistant to soil elements. They make a tight bond with the pipe . . . do not disintegrate with age . . . maintain continuously high electrical resistance.

KOPPERS **BITUMASTIC** ENAMELS
REG. U.S. PAT. OFF.

KOPPERS COMPANY, INC., Tar Products Division, Dept. 1103T, Pittsburgh 19, Pa.

Edgewater Beach Hotel, Chicago, April 9-11.

Southwestern Gas Measurement Short Course, University of Oklahoma, Norman, April 10-12.

American Gas Association, distribution, motor vehicle, and corrosion conference, Hotel Peabody, Memphis, April 16-18.

American Society of Lubrication Engineers, annual convention and lubrication show, Bellevue-Stratford Hotel, Philadelphia, April 16-18.

National Petroleum Association, Hotel Cleveland, Cleveland, April 18-20.

American Petroleum Institute, Rocky Mountain district spring meeting, Gladstone Hotel, Casper, Wyo., April 19-20.

Southern Gas Association, Buena Vista and Edgewater Gulf hotels, Biloxi, Miss., April 23-25.

Natural Gasoline Association of America, annual convention, Mayo Hotel, Tulsa, April 25-27.

Indiana Gas Association, French Lick Springs Hotel, French Lick, Ind., April 26-27.

American Gas Association, industrial and commercial gas section, industrial gas school, William Penn Hotel, Pittsburgh, April 29-May 4.

American Geophysical Union, thirty-second annual meeting, National Academy of Sciences, Washington, D. C., April 30-May 2.

American Petroleum Institute, division of refining, sixteenth mid-year meeting, Mayo Hotel, Tulsa, April 30-May 3.

May

Liquefied Petroleum Gas Association, annual convention and trade show, Stevens Hotel, Chicago, May 6-9.

Gas Appliance Manufacturers Association, natural-gas department spring meeting, Dallas, May 7-9.

American Petroleum Institute, division of production, Pacific Coast district, spring meeting, Biltmore Hotel, Los Angeles, May 10-11.

American Institute of Chemical Engineers, regional meeting, Hotel Muehlebach, Kansas City, May 13-16.

American Gas Association, operating section, production and chemical conference, Hotel New Yorker, New York City, May 14-16.

Pennsylvania Gas Association, Wernersville, Pa., May 15-17.

American Petroleum Institute, division of marketing, mid-year meeting, Cincinnati, May 28-29.

Third World Petroleum Congress, Kurhaus, Scheveningen, the Netherlands, May 28-June 6.

American Petroleum Institute, standardization and standing committees, division of production, mid-year meeting, Brown Palace Hotel, Denver, May 28-June 1.

June

American Society of Mechanical Engineers, semiannual meeting, Toronto, Ont., Canada, June 11-15.

Canadian Gas Association, Bigwin Inn, Lake of Bays, Ont., Canada, June 16-20.

American Society for Testing Materials, annual meeting, Atlantic City, N. J., June 18-22.

NOMADS

Tulsa Nomads, third Friday of each month. After Five Room, Tulsa Hotel.

Dallas-Fort Worth Nomads, first Monday of each month, Greater Dallas Club.

Houston Nomads, second Monday of each month. Ye Ole College Inn, Houston.

Los Angeles Nomads, second Wednesday of each month, Jonathan Club.

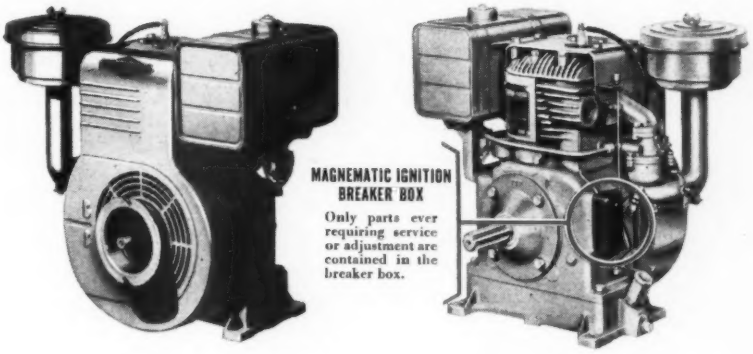
New York Nomads, annual Christmas dance, December 9, Hotel Pierre.

ONLY BRIGGS & STRATTON HAS THE MODERN

Magnematic Ignition

(Patents Pending)

STANDARD EQUIPMENT ON MODELS 9-14-23



MAGNEMATIC IGNITION BREAKER BOX

Only parts ever requiring service or adjustment are contained in the breaker box.

A Dependable Spark For Better Engine Performance at ALL SPEEDS

Magnematic Ignition delivers a dependable spark at lower speeds and better engine performance at all speeds.

LONG SPARK PLUG LIFE — magneto output tailored to engine requirements — sparks only on firing stroke — voltage decreases as speed increases, substantially lengthening spark plug life.

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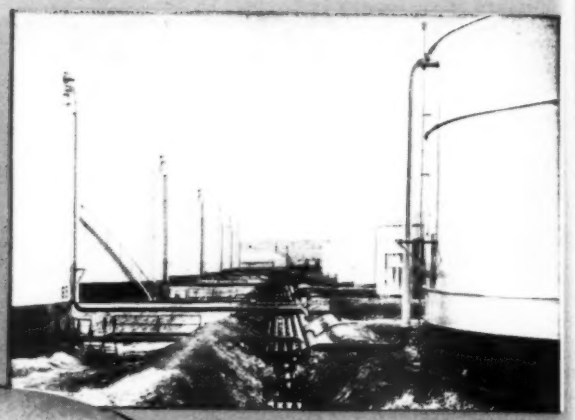

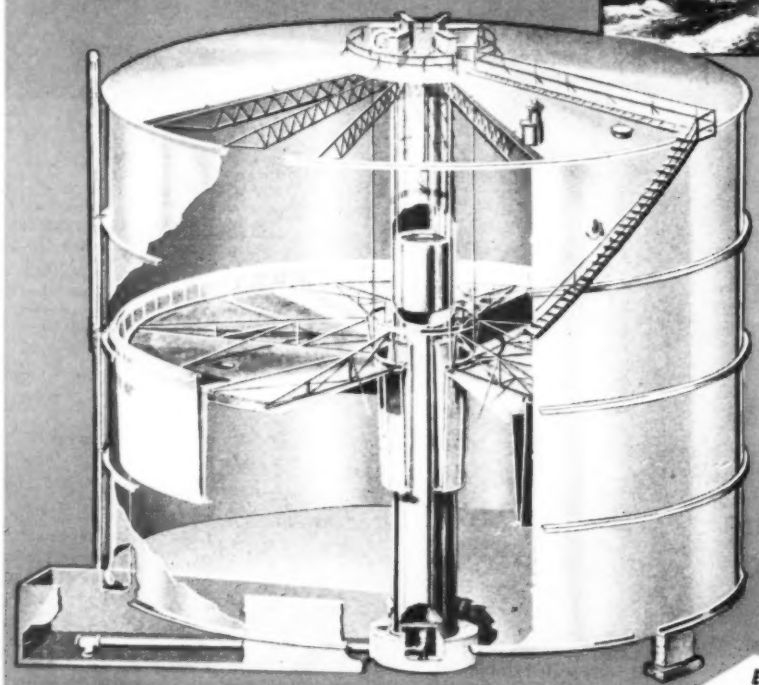

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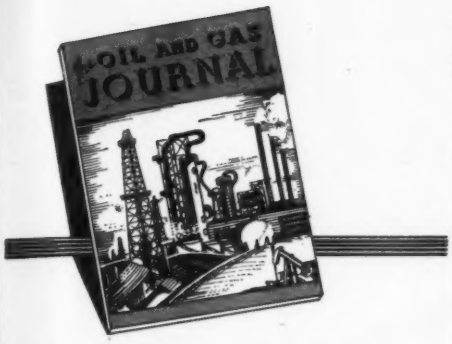

Published every Thursday by The Petroleum Publishing Co., 211 S. Cheyenne, Tulsa, Okla. Founded in 1902. Name changed to The Oil and Gas Journal in 1910 by Patrick C. Boyle.

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JOURNALLY Speaking

Shifts

WE ought to let you find this out for yourself instead of telling you about it, but a couple of our regular features are being shifted around, starting this week.

The technical sketches which portray the "engineering" interpretation of the news by Mr. Rube Goldberg will now appear toward the back of the book along with our field reports on wildcatting activity. This should tend to liven up the drab-looking but highly important pages of 6-point type in that section and also provide more space up front for "straight" news which—we insist—is always presented without any "interpretation."

The other shift involves our calendar of forthcoming meetings and events of interest in the world of oil and gas. In the past this has always appeared on the last page, just inside the back cover, but too often other things hogged this space so that the calendar had to be severely truncated, as in last week's issue. In this issue, and until further notice, the calendar will be found just to the west of the page you are now reading, along with our "They Say" department.

Food for Thought

HERE'S one that was sent in by one of our spies during Oil Progress Week, but we saved it to give a little California flavor to this issue in honor of the A.P.I. meeting there.

It seems Dean Metzner of Tokheim Pump Co. was trying to board a crowded San Francisco street car while wearing an O.P.W. lapel tag reading "Oil Is Okay." "So oil is okay?" wisecracked the conductor. "Ever try it on mashed potatoes?" Great guffaws of laughter from the passengers. Conductor takes a bow. "Have you ever tried it?" comes back Metzner real quick-like. "Come to think of it," meditates the conductor scratching his head, "don't guess I have."

Now Metzner is wondering whether the oil industry has missed a bet by not trying to add food products to the several thousand things already being made from petroleum, but the last we heard he has not experimented with it on mashed potatoes.

A.P.I Foot Note

THE Los Angeles chiropodists and sellers of soft shoes ought to do a big business this week, what with some 5,000 oil men there for the A.P.I. meeting. We don't want to belittle the program, but to a casual observer it would seem that the chief activity of an A.P.I. meeting is standing around the hotel greeting friends. This year, the meeting being where it is, many of the delegates are going to do a lot of sightseeing in addition. Both these occupations involve considerable wear and tear on the pedal extremities, and those who failed to bring along their most comfortable footwear are going to find their dogs barking before the week is over.

Woolly Bears

WE are off the woolly bears. Last year this department reported that the old timers in eastern Pennsylvania and upstate New York predicted a mild winter from the length of the brown stripe on the backs of woolly bears, a kind of caterpillar found in those parts.

This year we are ignoring the subject. Everybody else is getting into the act, with the usual confused results. According to reports reaching us, every fuel-oil dealer and oil-industry economist has been sending scouts all over the area measuring woolly bears and plotting the resulting curve to forecast the demand for heating oil. The result is no better than when the forecasters worked without the aid of the woolly bears. Some say the winter will be mild, some say it will be severe, some say it will be variable. It has developed that the woolly bears in different regions don't agree—which puts them in the same class as the forecasters, and the heck with them.

All we will say is that around Tulsa the squirrels are gathering lots of nuts and the bark on the trees is tighter than usual, which, according to the natives, is a sure sign of a cold winter hereabouts.

—Henry D. Ralph

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VOL. 49, NO. 28

November 16, 1950

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Subscription rate to the petroleum industry, United States and foreign, 1 year, $3.00. Single copies, 50 cents. Back copies when over a year old, one dollar. Note: Payments from outside the U.S.A. may be in the form of an international money order or check on a U.S.A. bank. Entered as second-class mail matter at Tulsa, Okla., under Act of March 3, 1879. Copyright 1950 by The Petroleum Publishing Co.

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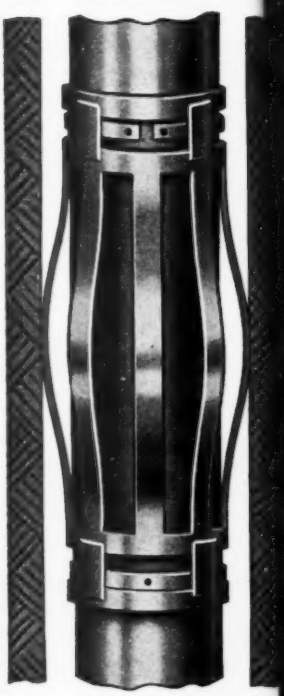

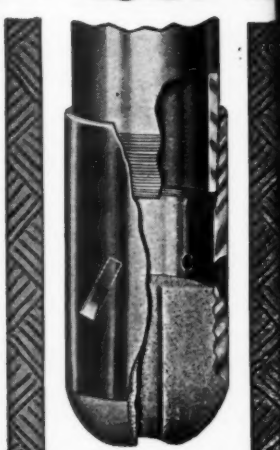

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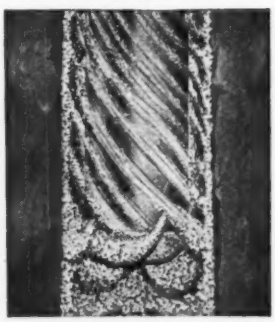

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The Changing A.P.I.

The program of the annual meeting of the American Petroleum Institute this year follows a trend evident since the end of the war. There is more emphasis on the over-all position of the oil industry and of its policies.

In this the A.P.I. both follows and leads a trend which is apparent throughout all industry. Businessmen generally are getting away from strict absorption with their own internal operating problem and are thinking more about the political, economic, and social conditions affecting them.

This does not imply that the A.P.I. is slighting the research and technical side of the industry. On the contrary, this part of its function is being intensified. But much of the discussion of technical matters is being shifted to regional and annual divisional meetings of the Institute.

At these smaller, more local, meetings there can be greater attendance by junior executives and men at the operating level, and more specialized discussion free from the distractions of the "three-ring circus" of the general meeting. This permits more people to participate and prevents the general meeting from becoming unwieldy as the industry grows in size and its technical problems become more diverse and ramified.

In recent years the annual A.P.I. programs have featured such subjects as public relations, marketing, economic conditions, political trends, international developments, and management problems. The Los Angeles meeting this week continues this pattern.

Some may call this trend an awakening of social conscience in industry. Others may say it is nothing more than self-defense against totalitarian government or other political interference. However it is viewed, this trend is here to stay and it is well and proper that the A.P.I. is conforming.

For an oil man to be a successful executive it is not enough that he be an expert in geology, or refining, or selling, or finance. If his firm is to endure he must keep it high in public esteem, and this means great attention to so-called management matters which are being discussed in Los Angeles this week.

And it is not only the "top brass" who should get interested in public relations, and taxes, and political trends. These should be the concern of junior executives, and of those who aspire to be executives, and of the operating men and women all down the line. Such subjects determine company policies which affect their jobs; and the way these people conduct themselves determines the public's attitude toward the industry.

The oil industry calls itself progressive. Modern usage of that term implies more than technological advancement. By its emphasis on broader problems of company policy and on the place of the oil industry in society, the A.P.I. is helping to keep the industry progressive in the social and political meanings of the word.

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THIS WEEK

A.P.I.—Preserving economic and political conditions under which petroleum industry grew and how to overcome steel shortage main theme of thirtieth annual A.P.I. meeting. . . . ¶Interior Secretary Chapman tells group that competitive nature, operating methods of petroleum industry will be preserved to "fullest extent" under any government controls. . . . ¶Domestic oil demand may rise to more than 8,000,000 bbl. daily, A.P.I. hears. . . . ¶Substantial synthetic-fuels industry seen by Bureau of Mines head. . . . ¶New-type diesel with silver bearings will subject lubes of future to extremely high operating temperatures, Navy spokesman says. . . .

STEEL—PAD tells NPA every effort should be made to increase petroleum reserves, recommends that 1,947,000 tons of tubular goods be earmarked for production, natural-gasoline operations in 1951. . . . Estimates 874,000 tons of line pipe will be required, as well as 992,000 tons of alloy and carbon-steel shapes and forms for petroleum-equipment manufacture. . . . ¶NPA orders steel producers to earmark supplies of steel for warehouses, and to allot tubular goods on percentage basis. . . .

INDUSTRY—FPC opens way for New England natural-gas service by splitting market between Algonquin and Northeastern. . . . ¶California Natural Gasoline Association commemorates twenty-fifth anniversary, reviews technical advances of past quarter century. . . . ¶Imports of crude, products dropped 18,000 bbl. in September. . . . ¶S.A.E. studies possible improvement of fuel systems for small aircraft and adaptation of L.P.G. for fuel in motor buses. . . .

INTERNATIONAL—U. S. competition, plus products price based independently of Western Hemisphere to determine price structure of Middle East oil, economist predicts. . . . ¶Soviet oil minister says big strides being made in Russian petroleum industry, gives no specific figures on production. . . . ¶Anglo-Iranian's Hamburg facilities, damaged during World War II, now completely rehabilitated. . . . ¶Leading member of military junta governing Venezuela assassinated. . . .

CANADA—Entire economy of country is being changed by Alberta's oil development, and Interprovincial's pipe line to Great Lakes. . . . ¶Important gas hearings now under way in province to determine natural-gas potentialities. . . .

ACTIVITY—Crude production for week ended November 11 averaged 5,835,275 bbl. daily, up 24,025 bbl. daily from previous week. . . . ¶Total completions gained 3 wells to 913 for the week compared with 752 last year. . . . Wildcat completions increased 11 wells to 168. . . . ¶Rotary rigs operating in United States on November 6 totaled 2,375, the second highest week this year. . . .

TRENDS—Refinery production of gasoline for 4 weeks ended November 4 was 8.8 per cent greater than same period last year. . . .Demand for refinery gasoline was 10.3 per cent greater than the high level for the same weeks of 1949. . . . ¶Gasoline stocks are now less than 100,000 bbl. greater than last year. . . .

REFINING—Derby Oil Co. to spend $2,000,000 on expansion of Wichita refinery. . . . ¶Dow Chemical completes new ammonia-producing facilities at Freeport, Tex. . . . ¶Initial engineering work under way on 8,000-bbl. daily T.C.C. unit to be installed at Taylor Refining Co.'s 22,500-bbl. plant at Corpus Christi. . . .

PIPE LINES—Flow of oil through common-carrier pipe lines reporting to ICC dropped 249,000,000 bbl. during 1949. . . . Total carried is smallest of any year since 1946. . . . ¶Westcoast Transmission asks FPC to approve 615-mile pipe line in Pacific Northwest to supply natural-gas markets in Oregon and Washington. . . .

A.P.I. SPECIALS.—Two sections of "The Oil and Gas Journal Special" Santa Fe train carried oil men from Tulsa and Chicago to the American Petroleum Institute thirtieth annual meeting in Los Angeles. Among those who boarded the Tulsa section November 10 were (in left photograph): W. W. Wolfe, Wolfe Drilling Co.; George H. Lang, Beacon Drilling Co.; J. L. Shakely, Jones & Laughlin Supply Co.; J. M. Gardner, International Derrick & Equipment Co.; W. H. Garbade, Deep Rock Oil Corp.; F. H. Dunn, Wilcox Oil Co.; Carl White, Franks Manufacturing Co.; W. A. Baden, Anchor Petroleum Co., and H. B. Gutelius, United Supply & Manufacturing Co. Chicago group (right) included: H. S. Knowles and Paul Summers, Parkersburg Rig & Reel Co.; Harry Fisher, Jones & Laughlin Steel Co.; L. C. Davidson and E. L. Stauffacher, Cities Service Oil Co.; H. S. Elkins, National Petroleum Association; and A. H. Rose, Ethyl Corp. The train sections will return to Tulsa and Chicago on November 18.

Oil's Challenge

Preserving economic, political conditions under which industry grew is major problem, A.P.I. members hear

Henry D. Ralph

LOS ANGELES. — The problem of greatest concern to the oil industry today is preserving the economic and political conditions under which the industry grew so that it can continue to operate in its traditional manner and fulfill its obligations to the public.

This central theme runs through much of the program of the thirtieth annual meeting of the American Petroleum Institute where more than 5,000 oil men are gathered to discuss the affairs of the industry from detailed technical problems to matters of high policy and international concern.

But predominant in all discussions were the subjects of steel and socialism—threatened shortage of material for operations and threatened encroachment of government control. As serious as the steel problem is, however, the threat of creeping socialism got top billing throughout the meeting.

The thread which ran through these discussions might be summarized thus: Never before has the oil industry been under such heavy attack as in the past couple of years. In Congress and the government agencies and from other sources have come a series of proposals to break up the oil industry as it now is, to impose hamstringing controls and tax provisions, and to make it appear that the industry is gouging the public and operating contrary to the national interest. This is interpreted as part of a world-wide movement toward collectivism and totalitarianism whether described as communism, socialism, or nationalization. For the oil industry to survive it must fight this trend on every side and with every weapon available.

Theme dominant. — This general theme was dominant in the address of the Institute's president, Frank M. Porter, and in that of Jake L. Hamon, who followed Porter at the opening general session. It also was stated in various ways by many other speakers at the several group sessions, showing how seriously the industry regards the danger to its economic climate.

There was a bright side to the picture, however. The Oil Industry Information Committee reported much progress in its campaign to inform the public about oil and to improve the public's esteem of the industry. It also laid plans for an even larger campaign and bigger budget next year.

The industry's leaders could also report success in defeating many of the proposals for government controls and adverse legislation, despite some failures, and they were unanimous in the view that free enterprise can be maintained if all persons in the industry make it their business to fight every proposal which threatens to undermine the industry's position.

Another example of how policy matters took equal prominence with technical subjects was the program of the financial and accounting sessions, where several speakers urged greater attention to relationships with employes, investors, and the general public. Of particular interest was the address of Max Lorimore of Union Oil Co., who analyzed the annual reports of 20 major oil companies and found that most of them fail to give information which the public should have for a proper understanding of how the oil industry functions.

Internal problems. — Internal problems of the A.P.I. received only routine attention at this meeting, in contrast to last year's gathering when the Institute was left without a president temporarily and when there were many proposals to reorganize the A.P.I. in several drastic ways. These proposals have been kept on the shelf, and the industry this year is looking outward toward its standing in the community.

Oil-Industry Controls

They will preserve competitive nature, operation methods of oil business to fullest extent, Chapman assures A.P.I.

LOS ANGELES. — The competitive nature and the present methods of operation of the oil industry will be preserved to the fullest possible extent in any controls which the Government finds it necessary to impose as part of the defense program, the American Petroleum Institute was promised by Secretary of the Interior Oscar L. Chapman.

Speaking also in his capacity as Petroleum Administrator for Defense, Chapman made these points:

1. The oil industry will be protected against antitrust prosecution for any collaboration undertaken as a result of formal requests from the Government.

2. A plan is now being formulated to obtain more steel for petroleum operations, but a control system may be necessary to accomplish this.

3. The PAD will be operated by oil men, will impose the minimum amount of control needed to do a specific job, will disrupt the industry as little as possible, and will drop its controls and go out of business as soon as it can.

4. The productive capacity of the oil industry must be expanded as a safeguard against an emergency and this can best be achieved by retaining the greatest degree of competition.

Victory in Korea, said the secretary, will not end the present defense program, for the nation must continue to prepare for an even greater emergency. Outlining the future problems, Chapman said:

"The Petroleum Administration for Defense will be the Government's agency on oil and gas, and within the purview of the responsibilities and functions delegated to me, it will be the only such government agency. It has started to work. It will continue to work until there is no longer any need for its services. Then, just as was true at the end of World War II, it will be disbanded.

Avgas problem.—The experience derived from the handling of the aviation-gasoline problem has proved most helpful. We have learned once again the value of a Government-industry partnership. A small group of industry technical experts, assembled under the leadership of the Petroleum Administration for Defense, has known what to do, when to do it, and where there were units within the industry who could do what had to be done. We have not needed formal directives, nor have we attempted merely to ration a shortage. Instead, by welding technical skill with economic incentives, a substantial increase in the production of these fuels has already been achieved. However, we are by no means yet out of the woods and we cannot afford the luxury of complacency. Neither Government nor industry can fail to plan for whatever the future may require.

Shortages disturbing.—"It is extremely disturbing to note the growing shortage in the supply of materials,

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equipment, and facilities required by the oil and gas industries. That shortage appears to be reaching alarming proportions so far as the supply of specialized steel products is concerned.

"The Petroleum Administration for Defense is acting to meet that problem. In consultation with experts from the oil and gas industries, we are preparing data now to support our requests for adequate supplies of steel and other critical materials needed by these industries. We will do our best to obtain these supplies. Unless they are forthcoming, the Government may be forced to regulate the use of steel or other critical materials in oil and gas operations. Such regulations may be the only way to attempt equitably to distribute materials in short supply and direct their use in the interests of the defense program.

"But allocations and rules to administer materials which are in short supply are not enough. We have learned in oil and gas that the safest and best way to meet expanding demands is to increase supply, not ration a deficiency. This belief in the virtue of expanding production has always been a characteristic of the oil industry.

Steel allocation. — "If allocations of steel or other products are required, we will adjust ourselves to the necessities of the situation. We will do so willingly, and if past experience be a guide, successfully. But we must never stop waging the fight for greater productive capacity. The simple fact is that inadequate capacity to make steel puts the brakes on our whole industrial machine and threatens both the national defense program and the civilian economy. It is time that the steel makers faced economic realties and raised their sights.

"During the mobilization period which lies ahead, certain basic principles should be our guide. We start with a partnership. If orders or directives are necessary, they will be evolved carefully, cooperatively, and with particular regard to the interests of the public and the many large and small businesses which make up this industry.

"I am sure that as the future unfolds the industry itself will agree that some directives and orders are necessary. But I think we should adopt the rule that whenever any order is issued, industry and Government should immediately search for ways and means which will make it possible to wipe that order off the books. The same principle should apply to the whole Petroleum Administration for Defense.

Antitrust protection.—"Whenever and wherever I conclude that cooperative action by the oil industry is necessary in the interests of the defense program, I shall not hesitate to use, at the appropriate time, whatever powers I may possess under the Defense Production Act, or otherwise, to make sure that no one can successfully claim that any such specific action formally requested or directed violates the antitrust laws. You were fully protected on this score during the days of the Petroleum Administration for War—you should be again. However, I am sure you do not expect any blanket endorsement of actions, past, present, or future, not directly related to specific conduct formally requested in the interest of the defense program. Antitrust questions are traditionally and properly for the courts to resolve. Accordingly, except as an antitrust litigation might of itself be determined seriously to jeopardize the defense program, the petroleum administrator would not be justified in even suggesting a postponement of such litigation.

Competition important.—"The security of this nation—the security of this industry—lies in its capacity to produce. Competitive industry built this capacity. Competitive enterprise maintains and increases this capacity.

"Undeveloped reserves in the ground, transportation facilities yet unbuilt, planned refineries, and new processes in the pilot-plant stage and distribution facilities anticipated but still to be constructed—these represent more potential capacity."

Key to Survival

Petroleum one of most important factors in determining whether free people will survive, Porter tells A.P.I.

LOS ANGELES.—Petroleum is one of the most important factors in the final determination of whether this and other governments of free people will survive, or whether the totalitarian philosophy of communism will prevail, Frank M. Porter, president of the American Petroleum Institute, told members gathered here this week for the Institute's thirtieth annual convention.

"The petroleum industry of the United States, and its investments and influence throughout the world, are definitely on the side of freedom," he said.

"Today, as in 1917, we face the possibilities of war. We face certainly a long period of mobilization—a mobilization which we pray will bring ultimate peace. The industry is preparing to meet a present or long-term emergency. Once more its members are patriotically volunteering their individual service to the mobilization effort."

Porter said that the oil industry again is prepared "to confirm what the founders of the American Petroleum Institute proved—that initiative, under free enterprise, is the best guaranty of the military security and the economic well-being of the people of America.

"Through unity, I have every confidence the oil industry will meet the critical problems it now faces."

The A.P.I. president said that he hoped to be able to maintain the high standard of representation for the industry to which it is entitled, as did the other presidents of the Institute.

Crucial moment.—"I am assuming my responsibilities at a crucial moment of history," he stated, "when the forces of freedom and dictatorship are struggling for world supremacy."

Porter praised the activeness of all the Institute's various branches, and of the leadership constructively displayed through its board of directors.

FRANK M. PORTER

Steel Situation

It is biggest problem facing oil, Porter says

LOS ANGELES.—The steel situation is the biggest problem facing the petroleum industry and its chief topic of discussion today, Frank M. Porter, president of the American Petroleum Institute, said at a press conference in connection with the Institute's annual meeting here.

Doubtless part of this is due to poor distribution of the present supply, he said, but "there must be some basis for the universal complaints

that the over-all supply of steel is inadequate to meet requirements." Porter declined to propose any specific plan to secure more steel for oil operations, but said he was confident that the Government and the steel industry would find a solution soon.

The oil industry itself is in excellent shape to meet any emergency, Porter said, and has done a remarkable job of preparing for defense needs and of cooperating with government agencies in planning the enlarged military program.

No oil shortage.—There is no reason to anticipate any shortage of civilian petroleum products this winter, he said, and no one in the industry appears to be too concerned over the industry's ability to meet emergency demands if sufficient steel is available. Should the international situation take a decided turn for the worse it would be necessary to make a number of rearrangements of transportation facilities, but as yet there is no indication whether the heavy demand would be on the East Coast or the West Coast, he said.

He predicted 1951 should be a record year for the entire oil industry. Drilling at present is at the rate of about 44,000 wells per year, and he said steel simply must be made available to drill 40,000 or 42,000 wells during 1951.

Proven reserves.—Proven reserves of crude oil should show a substantial increase when the 1950 figures are compiled, he said, but whether or not they will be adequate for all possible needs will depend on future military demands and on the amount of excess producing capacity which is desired as a cushion against emergencies.

Some increase in refining capacity will be needed before long if military demands increase, particularly in cracking plants and facilities for producing aviation gasoline and other highly refined products, Porter predicted.

A.P.I. REGISTRATION.—Oil men gather around the official registration desk of the American Petroleum Institute at the Biltmore Hotel in Los Angeles. More than 5,000 are attending the thirtieth annual meeting of the Institute this week, to hear of progress in all phases of the industry.

Oil Must Lead

Hamon says industry must ward off bureau controls

LOS ANGELES.—The petroleum industry must lead the fight to resist socialistic controls of all industry within this country, Jake L. Hamon, president of the Mid-Continent Oil and Gas Association, told members of the American Petroleum Institute this week.

Speaking at the opening general session November 15, Hamon chose a different line of reasoning from that of Frank M. Porter, A.P.I. president, in his speech, but arrived at the same conclusion: that the petroleum industry is the world's chief bulwark against the spread of Communism.

He agreed with Porter that the campaign to preserve free enterprise is the biggest job facing the industry and that it can be done only through the cooperation of all individuals engaged in the petroleum business.

Hamon said that the fight against Communism—or socialism or nationalization, or bureaucratic controls—"is your fight and my fight." He pointed out that all industry is facing the same fight as the oil industry, and urged a common front against socialized medicine, nationalized steel, government control of farms or railroads, and similar inroads on free enterprise.

For instance, he said, the oil industry should not run to Washington asking for controls on steel if it seeks to avoid government controls on oil.

Tracing the many threats to the oil industry's freedom which have had support in Congress and in public opinion in recent years, Hamon said the explanation for this is that the oil industry is the freest of all and therefore the biggest target for those who seek to undermine free enterprise.

Domestic Oil Demand

It may rise to more than 8,000,000 bbl. daily, with heat, power generation taking big share, A.P.I. hears

LOS ANGELES.—Domestic demand for oil in 1960 may rise to something over 8,000,000 bbl. daily, Chester F. Smith told American Petroleum Institute refining and marketing men this week.

Smith, vice president of Standard Oil Co. (N. J.), and A.P.I. vice president for refining, predicted that over half of this increase would result from higher requirements for the generation of heat and power. The total increase represents an average gain of just a little less than 3 per cent per year.

"Fuel requirements for highway vehicles may increase by about 2.5 per cent per year, averaged over the next decade," Smith said. "The growth in motor-fuel demand may be roughly proportionate to increases in vehicle population, since increased mileage per vehicle is expected to be just about offset by improved fuel efficiency. The average number of vehicles of all kinds on the road may reach 50,000,000 by 1960."

Increases in oil requirements for transportation other than vehicles were placed by Smith at about 1 per cent per year up to 1960. He explained, "The rapid growth anticipated for the more efficient diesel engine in railroad transportation, together with the reduced outlet for residual fuel-fired steam engines, may result in only a slight increase in total oil consumed by railroads."

Heating trend.—Smith called attention to the trend toward faster-than-average growth in the use of energy in heating and power generation and the slower prospective rate of growth in use of energy for transportation. Concerning oil demand for transportation, Smith said, "In 1937, these uses accounted for 70 per cent of oil consumption—in 1949 they were down to 64 per cent, and during the next decade a further decline to below 60 per cent is anticipated."

Pointing out that the petroleum business must look increasingly to the stationary uses if it is to continue its accustomed rate of growth, Smith warned that competition from natural

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gas may be a limiting factor in the growth of oil in stationary uses.

"Just as oil has had the overwhelming advantage in the transportation field for the past several decades, natural gas and hydroelectric power, I believe, will have an advantage in stationary uses for years to come. Their share of tomorrow's energy market may be limited only by their availability to the consumer," Smith said.

However, he predicted that the total energy demand of the future will be great enough for growth by all fuels.

Production forecast.—Concerning the required level of crude production at the end of the 10-year period, Smith forecast production of crude alone at 6,500,000 bbl. daily compared with 5,400,000 bbl. daily this year, and expressed confidence in the industry's ability to meet these needs. "Indeed at that level, it is expected that there will still be a desirable working reserve in 1960—perhaps in excess of half a million barrels per day," he said. "I think we can use the present guesses of yet-to-be-discovered reserves to indicate that we are a long way from running out of oil."

Synthetic-Fuels Future

Boyd sees substantial industry; says gulf between demand, supply will have to be met by synthetic fuels, imports

LOS ANGELES.—Research on synthetic fuels has progressed to the point where it has set a ceiling on the prices of petroleum products and the time may not be distant when economic considerations will bring about a substantial synthetic-fuels industry, the American Petroleum Institute was told by James Boyd, director of the U. S. Bureau of Mines.

Addressing a joint session of the divisions of refining and marketing, Boyd painted no alarming picture of the demise of the oil industry nor did he raise the threat of government subsidies for synthetic fuels.

Rather, he said that the oil industry is the logical one to handle this business, particularly after the coal or oil shale is brought above ground, and he predicted a gradual shift of some parts of the liquid-fuels market to synthetics. He admitted that many technical problems remain to be solved, but said that already costs have been reduced to such a point that synthetic fuels are approaching a competitive range with petroleum products and he predicted that several synthetic-fuels plants will be in operation within a decade.

"For some years," Boyd said, "new oil fields discovered in the United States have been decreasing in size and importance. The opposite is true of discoveries made abroad. Whereas the average new field found in this country rarely exceeds 2,000,000 bbl. of recoverable oil, the 300 fields discovered abroad during the two decades prior to 1943 have an estimated ultimate yield averaging about 100,000,000 bbl. each. Our potential oil land, of course, has been far more intensively explored."

Significant decade.—The Mines Bureau director said that this year marks a significant decade—a decade in which eminent authorities in both the petroleum industry and government have indicated that domestic petroleum production probably will pass its peak, and may begin a long gradual decline. "Moreover," he said, "they anticipate that this decade will witness the birth and initial development of a new basic industry engaged in producing synthetic liquid fuels initially from gas; then oil shale, and coal.

"Barring unexpected developments in atomic or solar energy, the anticipated widening gulf between domestic demand and supply ultimately will have to be met by synthetic liquid fuels and imports."

Boyd said that of the two, only synthetics could offer an assured supply from known resources within our own borders—"a supply which is not subject to vulnerable sea lanes, foreign expropriation, or exhorbitant taxes and concession fees."

Citing costs, Boyd said that the bureau's engineers estimate that recent research and development achievements in the synthetic liquid-fuels program means that refined products now can be produced from oil shale and coal at estimated actual costs averaging 7.3 cents and 10.8 cents per gallon, respectively, with credit for chemicals and other byproducts.

JAMES BOYD

"Without credit for chemicals, the cost averages would be 7.9 cents a gallon," he said, but emphasized that these estimated costs do not include return on investment. "However, they are approaching the competitive range. Further reductions are certain as technical knowledge is advanced, permitting additional process improvements."

"A synthetic fuels industry of significant proportions hardly could be established during a war if the nation had to start from scratch. Instead, as in other basic industries, the pioneer commercial units first must be available to serve as a pattern on which to expand as rapidly as necessary." He said that in order to cut costs, similar benefits for the synthetic fuels industry, similar to Congress' income-tax provisions allowing deductions for depletion and intangible drilling costs, might be necessary to stimulate synthetic fuels production by private capital.

He said that crude shale oil now can be refined readily to useful products, since its sulfur and nitrogen content is no longer a major problem. "A mild hydrogenation of the crude oil will yield jet fuel, diesel fuel, and fuel oil meeting military specifications," he said. "A supplemental thermal or catalytic cracking step is necessary to make motor gasoline."

Capital investment.—He said the capital investment now required for a plant producing 8,840 bbl. daily of refined products from oil shale is esimated at $41,381,000, including facilities for mining, retorting, and refining. "This is an average of $4,681 per daily barrel of finished product. From a defense standpoint, it is significant that steel requirements for shale-oil plants are relatively modest in comparison with those of either coal-to-oil plants or new petroleum facilities, plus exploration and development."

In discussing chemicals from coal, Boyd said that a single 30,000 bbl. daily coal-hydrogenation plant, producing principally gasoline and liquefied petroleum gases, could make a major contribution in alleviating shortages of benzene and aromatic hydrocarbons, together with phenol and other commercial tar acids. "For example," he said, "the estimated annual yield of a plant of this size would include 34,000 gal. of benzene, 49,500,000 gal. of toluene, 50,300,000 gal. of xylenes, 34,500,000 lb. of phenol, 57,000,000 lb. of cresol, and 75,000,000 lb. of xylenols. This is equivalent to almost 20 per cent of the nation's 1948 production of benzene and 11 per cent of the phenol output reported in that year."

Heavy-Duty Lubes

New-type diesel with silver bearings will subject lubes to high operating temperatures, Navy spokesman predicts

LOS ANGELES.—Lubricating oils in the future will be exposed to extremely high operating temperatures in new diesel engines now under development — engines having "silver" bearings which will apparently be required to obtain the highest output under the severe operating conditions imposed upon the engines, Capt. William C. Latrobe, U. S. Navy, director of the materials, development, standards, and specifications division of the Bureau of Ships, Washington, told members attending the lubrication session held under auspices of the A.P.I. division of marketing.

In discussing heavy-duty-engine lubricating oils, Latrobe said that "We may be forced to take fuels which will contain 1 per cent sulfur or more," and stated that he personally looked upon the trend in the use of silver bearings "rather fearfully."

"The engine designers and maufacturers may not have worked closely with the petroleum technologists interested in assisting in the development of heavy-duty oils for the more severe duty which may be expected in these new engines," the captain said.

Refiners concerned.—"We know that a number of refiners are concerned with silver bearings, because silver bearings of one type or another are used in railroad service. At the moment we cannot attempt a correlation of the railroad silver-bearing problems without ours because we do not have sufficient operating experience with silver bearings. Furthermore, I feel that our experience has been insufficient to indicate conclusively whether high-sulfur fuels will impose a requirement for greater detergency in our lubricating oils."

Must keep pace.—Latrobe said: "We are concerned with the future need for the development of heavy-duty engine oils. It is important that oil development keep pace with engine development, and with the new operating conditions as obtained in our Snorkel submarines. Economically, an increase in additive content may be extremely important because it may bring about a shortage of one of the additives," he continued. He said the type referred to may be the same as required to improve certain No. 2 furnace oils, as well as certain types of U. S. Navy diesel fuels expected to be encountered in an all-out mobilization.

"The volume of lubricating oils involved, when all the military services are considered, are huge," he said.

"During World War II the U. S. Navy procured for its own use 8,000,000 bbl. of lubricating oil, although the Bureau of Supplies and Accounts purchased for all three services and our allies about 40,000,000 bbl. However, in spite of possible supply difficulties, we must look to the newer and improved heavy-duty-engine oils in order to get better military characteristics in our diesel engines.

Latrobe said that diesel fuels today are showing an increase in the percentage of sulfur, and under one type of submarine-engine operation, they are giving the heavy-duty-engine oils "a greater workout." He said tests indicate that the higher-sulfur fuels under today's operating conditions may give the Navy more deposits and double the normal wear.

"If we are not alert to prevent this," he warned, "we may have a repetition of stuck rings, piston seizures, and crankcase explosions. This we do not want."

Also appearing at the lubrication session were Col. Benjamin S. Mesick, chief of research and material branch, research and development division, Office of Chief of Ordnance, Washington, and Dr. Gustav Egloff, Universal Oil Products Co., Chicago.

Col. Mesick summarized military fuels and lubricants from the standpoint of the Army's technical requirements, and pointed out that military performance standards are much more severe than those normally encountered in civilian use. He said that two characteristics in need of further improvement are storage and oxidation stability.

Dr. Egloff told of the strategic importance of the prolific sources of oil in the Middle East and their effect on the fueling of a long war, and what it would mean to the countries of the West if this enormous supply should be cut off by Russia or her satellites.

(Both Mesick's and Egloff's papers appear in the special A.P.I. section of this issue.)

Nomenclature Unchanged

LOS ANGELES.—Any attempt to rewrite the nomenclature for crankcase oils at present would be premature because there is as yet insufficient experience with the new heavy-duty types being tested by the military and others, it was reported to the lubrication committee of the marketing division of A.P.I. by a special subpanel on the subject.

The report, which was accepted by the full committee, recommended that no action be taken at this time. It pointed out that there are five different performance levels of heavy-duty-type oils that have been established on the basis of government and manufacturers specifications.

To freeze these five types by A.P.I. nomenclature and S.A.E. definition would lead to a multiplicity of brands and grades, the report said, and would preclude any subsequent move to combine and simplify the setup as a result of experience. The report explained that the Navy still has its own series and has not accepted the military series and there appears to be no immediate prospect of a consolidation such as was anticipated by industry.

Other reasons given were that there has not been sufficient experience with the new types to determine their performance; there is no certainty that experience will show that five different types are necessary; and the performance of the new oils under various types of fuel and sulfur conditions has not been tested.

For much the same reasons the committee declined to reconsider the designations "regular" and "premium" for crankcase oils. It indicated a general dissatisfaction with the present use of these terms but said no revision should be made until the situation regarding heavy-duty types has been clarified.

Opinion Poll

Public thinks more of oil industry, survey reveals

LOS ANGELES. — The American public thinks considerably better of its oil industry now than it did only a year ago, it is indicated in a report submitted to the Oil Industry Information Committee meeting in conjunction with the A.P.I. convention.

This showed that 72 per cent of the public has a favorable opinion of the industry, compared with 68 per cent in 1949.

The report was based on a survey made by Opinion Research Corp., Princeton. It was a spot check and not so extensive as the elaborate report presented last year, but covered a sufficient sample to show that the industry's public-relations program is achieving results.

To the question: "Is your general impression of the oil industry a favorable or unfavorable one?" Opinion Research obtained these results:

	Per cent 1949	Per cent 1950
Favorable	68	72
Have no impression	14	15
Unfavorable	12	9
Don't know	6	4

This year's survey, which continues the committee's practice of checking regularly on the public's attitude toward the oil industry, had two main purposes: To check on any shifts in public opinion that have occurred since last year, and to investigate

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A.P.I. TECHNICAL GROUP.—This committee on fire protection, meeting in Los Angeles during the thirtieth annual convention of the American Petroleum Institute, is typical of the more than 100 technical committees which have specific responsibilities in helping to solve the operating and construction problems of the oil industry.

the public's thinking on new issues which may have arisen as a result of the Korean conflict and the mobilization program.

In addition to the increase in the over-all favorable impressions of the industry, the survey shows that the public's views on service and product improvement are slightly, but consistently, more favorable in 1950 than they were in 1949.

Highlights.—Some of the highlights of the survey are as follows:

Eighty per cent of the American people think the oil industry tries to serve the best interests of the public as a whole—a gain of 4 per cent over 1949;

Eighty-two per cent of the people say the oil industry does as good as or a better job of product improvement than any other industry—a gain of 4 per cent;

A majority of the people believe oil companies are quick to adopt new improvements, and 60 per cent of the people chose service stations over other retail businesses offering the best customer service.

Pipe-Line Stations

Unattended installations cut costs, symposium told

LOS ANGELES. — It is no longer wishful thinking to believe that pipe-line pump stations can be operated with push buttons or remote hydraulic or electric controls. Such stations are now in operation and have proven their value in effecting still greater economies in the transportation of petroleum products, H. E. Fisher, products pipe-line department, Standard Oil Co. (Ind.), told A.P.I.'s division of transportation at a pipe-line symposium here this week.

Fisher said that the full utilization of automatic, semiautomatic, and remotely controlled pump stations is one of the most recent developments in products pipe-line technology.

"One operator," he told the group, "has reported on the successful design and operation of an intermediate, unattended, remotely located station utilizing the new vertical stuffingboxless pump, which eliminates the stuffing boxes and packing which are the principal reasons for operational attendance and maintenance required by the conventional pumps. This station is pressure operated, and may be started or stopped by hydraulic control from the preceding station on the line."

Fisher noted that one of the principal advantages of the vertical stuffingboxless pump is that in the event of a complete power failure, the stream can bypass the station by continuing flow through the pump case, which eliminates one of the many safety hazards prevalent in the use of conventional pumping equipment.

Investment small.—Initial investment of this small station, Fisher said, was reported to be no greater than a similar conventional station which demands an attendant at all times. Additional expenditure for necessary automatic equipment was offset by economies effected in the building, heating plant, and other facilities required at an unattended station.

In discussing semiautomatic stations, Fisher said that other operators have such stations which will start, run, and shut down in accordance with intelligence information supplied to the automatic equipment by an orifice meter in the line; suction and discharge pressure being automatically controlled by pneumatic diaphragm valves. All are designed for fail-safe action, he said.

Remote control.—Discussing remotely controlled pump stations, Fisher said that one major operator had recently constructed and put in service stations operated by push-button controls over a leased teletype system utilizing four selector switching circuits. The stations have no throttling controls, but operate wide open whenever on the line, and are started and shut down as the hydraulics of the line requires. This permits more satisfactory control of the station than can be accomplished by pressure of flow control alone.

C. L. Goodwin, Portland Pipe Line Corp., Portland, Me., discussed new developments in coatings and cathodic protection of pipe lines during one of the two pipe-line symposiums. The problem of internal pipe-coating and developments in its technique, were discussed by J. K. Alfred of Shell Pipe Line Corp., Colorado City, Tex.

Developments in the field of large-diameter river-crossing construction on pipe lines, the problems involved, and how they are solved, were explained by F. Hill Sanders, Jr., Sun Pipe Line Co., Beaumont, Tex., Milton Ludwig and Sidney P. Johnson, Standard Oil Co. of California, San Francisco, presented a detailed technical paper on prediction of surge pressures occuring in oil-transmission lines of considerable length.

G. H. Supple, General Petroleum Corp., Los Angeles, and R. Charles Nicholson, Shell Pipe Line Corp., Houston, told symposium members how changes in the Institute's Code 25 can be improved.

Cites Present Oil Policy

LOS ANGELES. — The American petroleum industry has reached new production records under principles of a national petroleum policy recommended by a special investigating committee back in 1945, B. L. Majewski, Chicago, vice president of marketing for Deep Rock Oil Corp.,

told A.P.I. marketing division members here.

"As long as the industry is allowed to operate freely on the basis recommended by that committee, and as long as the executive branch of the Government adopts the attitude 'so clearly and frankly stated' by Secretary of Interior Chapman, we have no fear of the oil industry's ability to meet any call which may be made upon it by the American people in peace or in war," he said.

Majewski noted that Sen. Joseph C. O'Mahoney of Wyoming, as head of the committee on interior and insular affairs, announced that public hearings would be held after November 15 pursuant to the Myers resolution adopted by the Senate, which calls for an inquiry into all available fuel reserves of the United States, and which has been asked to formulate a national policy for both peace and war which would apply to use of all fuels and energy resources except atomic energy.

O'Mahoney headed the 1945 committee which laid down the basic principles under which the oil industry has been functioning, Majewski reminded the group.

This has resulted, Majewski said, "that the industry finds itself today with a larger producing, transportation, and refining capacity than at any previous time in its history."

"Our political and economic future does not lie in burdening the federal Government with all the problems which we ourselves refuse to solve. We must not change the State into an economic administrator. America has grown strong on personal initiative."

California Oil

Plenty is available for a few years, but shortages may be likely as use increases, Minckler tells A.P.I. group

LOS ANGELES.—Present military and offshore demands are cutting into California crude-oil stocks at the same time which finds the area with a rather small inventory of undrilled proved locations, R. L. Minckler, General Petroleum Corp., Los Angeles, told a group session of the A.P.I. division of production here this week.

"With crude-oil production of about 935,000 bbl. per day at the present time, it is evident that the local civilian market can be met from our own production for several years, even without important discoveries," Minckler stated.

But above this is the 90,000 bbl. per day needed by the Armed Forces, the 71,000 bbl. per day foreign market, and the 88,000 bbl. per day being shipped to other American coasts that has run the total demand of the area up to 1,081,000 bbl. per day and resulted in a withdrawal of 120,000 bbl. per day from inventories, he said.

Minckler forecasts in 1951 the disappearance of the intercoastal markets, a military market guess of 100,000 bbl. per day, a Pacific foreign market of 50,000 bbl. per day, and a firm domestic demand of about 850,000 bbl. per day, or a total requirement of 1 million barrels per day.

Production picture.—To meet a demand of 1 million barrels per day, Minckler stated that crude-oil production of a little more than 900,000 bbl. per day, along with natural-gasoline production and normal receipts from other districts, will be required. "So another way of stating the problem is can California continue to produce 900,000 bbl. per day for the next several years?" he said.

On this question Minckler commented: "As I see the picture, we have plenty of oil in California for a few years more, but I believe that we are approaching finally the day when there will be a shortage of over-all local crude-oil production. The old cushion of unused production capacity is about gone and productive capacity will be very close to market demand."

Minckler pointed out that California has had a very low development drilling rate for the past 2 years and a rather small inventory of high-grade undrilled proved locations.

"The only first-class oil field found in California during the past 10 years is Cuyama, and even Cuyama looks pretty small in geologic time measured up against a million barrels per day demand," he added.

"Probably there are a few more Cuyamas lying around somewhere in California, and more small fields will, of course, be found, but the present prospect is that the finding costs will be very high and the rewards pretty small."

Elk Hills Reserve and tidelands oil were discounted by Minckler, because of political difficulties.

Conservation Block

Lawyer says capture rule can be set aside by court

LOS ANGELES.—The old legal "rule of capture" which has been such a stumbling block to oil conservation can be set aside by court action instead of waiting for the state legislatures to enact new statutes, the A.P.I. division of production was told by George W. Hazlett, Cleveland oil attorney.

If cases are presented to the courts in proper fashion, he said, it is quite likely that the common-law rule of correlative rights will be invoked by the judges to sanction unitization, pressure-maintenance, proration, and similar engineering practices leading to maximum recovery.

In presenting this somewhat novel view, Hazlett traced the history of the common-law rule that oil in the ground belongs to whoever produces it first, saying it was based on the erroneous belief that oil moved as a river underground. At the same time, he pointed out, the courts for generations have applied the rule of correlative rights to the use of streams and have held that one riparian owner may not use the water in such a way as to destroy the property of others.

Hazlett urged the oil industry to test this doctrine as applied to oil production by giving the courts the facts of oil reservoirs as a basis for reversing the time-honored rule of capture.

Depletion Defended

Humble president says present set-up successful

LOS ANGELES.—The percentage depletion provision has worked admirably to protect the capital value of oil production so as to encourage operators to risk once again in the search for oil the capital recovered in the course of production, Hines H. Baker, president, Humble Oil & Refining Co., Houston, told members of the A.P.I. at a division of production group session here.

The provision has worked to encourage all operators, regardless of size, and it has become a part of the economic structure of the industry.

"It cannot be changed without serious influence on the entire cost-price relations in the petroleum industry," he said. "Any increase in taxes would result in either an offsetting increase in prices, to the detriment of consumers, or in less development of new resources to the disadvantage of national security and future economic progress."

Texas Cuts Allowable

AUSTIN.—The Texas Railroad Commission on November 14 cut December production 160,093 bbl. daily, representing a 1-day cut for the state generally.

The new 20-day schedule for Texas fields, with 19 days for East Texas, reflects the present crude-stock situation, which has been termed favorable at this time. Daily allowable for December will be 2,556,994 bbl.

XUM

Silver Anniversary

Natural-gasoline industry's technical advances over past quarter century discussed at C.N.G.A. meeting

D. H. Stormont

LOS ANGELES.—In keeping with the occasion—the commemoration of its twenty-fifth anniversary—the California Natural Gasoline Association in its annual meeting here November 9-10 presented a program which summed up the industry's technical advances of the past quarter century. Current problems, both technical and economic, likewise received a thorough discussion during the 2-day meeting.

The services C.N.G.A. has rendered to the petroleum industry in the 25 years which has passed since the group's first meeting at Signal Hill on December 2, 1925, were recounted by the association's president, R. S. Tulin of Shell Oil Co. Two points he brought out were that it is an association of individuals, not companies; and that its founders intended it to "provide a common meeting ground where those interested may discuss those problems which are peculiar to the natural-gasoline industry and cooperate to such an extent as may seem necessary or expedient."

That C.N.G.A. has not deviated from its original purpose was fully illustrated by four forums held concurrently November 9. One was devoted to the efficient operation and maintenance of plant equipment. A second dealt with the application of chemical and process-engineering principles to efficient design and operation, while the third covered the role of the chemist and laboratory. The fourth, and the one which drew the greatest attendance, highlighted progress in gasoline-plant equipment and design.

Panel discussion.—During the morning session, November 10, with R. W. Heath of Signal Oil & Gas Co. serving as moderator, the forum chairmen presented a panel discussion of "Attaining Over-all Efficiency in Natural Gas and Natural Gasoline Operations." These authorities, who presided at the forums in the order mentioned above, were J. B. Taylor of Signal Oil & Gas Co.; C. D. Gard of Union Oil Co.; W. W. Robinson, Jr., of The Texas Co.; M. W. Kibre of General Petroleum Corp.; and L. V. Leonard of Shell Oil Co.

During the 2-day session a total of 31 technical papers or addresses were given. In following paragraphs, highlights from some of these are presented.

Gas utilization.—In discussing "Conservation of Natural Gas in California," T. L. Taggart of Standard Oil Co. of California emphasized the significance of price. In this respect he stated that increased field prices have made it economically feasible to install facilities to conserve gas. Some of the measures being taken now are justified at present price levels whereas they would not have been at the prices being paid less than 10 years ago. As prices continue to increase, he believed further steps in this direction can be taken.

These gas-conservation steps, however, have caused California's gas economy to change from a surplus to a shortage, he pointed out, and have brought about the development of dry gas fields and the importation of Texas gas. The latter is expected to average 400,000,000 cu. ft. daily this year and by 1952 increase to 800,000,000 cu. ft., he said. The dry-gas fields, coupled with underground-storage projects for Texas imports, provide the means for meeting peak demand loads.

The great contributions the light-hydrocarbon industry is making to the American way of life were highlighted by Warren G. Kraft, Honolulu Oil Corp., in the afternoon general session on November 10. He first brought out how a typical plant's residue gas makes possible greater oil recoveries through gas-injection programs, how it serves as a heating fuel, and is the charging material for producing carbon black and ammonia. He then described the many uses for the plant's liquid products in chemical industries, rubber manufacturing, as

Most of C.N.G.A. past-presidents are shown in this group. Seated, left to right: T. L. Taggart of Standard Oil Co. of California; H. L. Eggleston, Los Angeles analyst; R. E. Beckley, Standard of California; R. W. Heath, Signal Oil & Gas Co.; Paul D. Barton, Sun Oil Co.; N. H. Mull, The Texas Co.; M. W. Kibre, General Petroleum Corp. Standing: P. S. Magruder, General Petroleum; R. S. Tulin, Shell Oil Co., current president; F. J. Colton, Tide Water Associated Oil Co.; R. D. Gibbs, Union Oil Co.; M. L. Arnold, Richfield Oil Corp.; L. V. Cassaday, Lomita Gasoline Co.; H. R. Linhoff, Richfield; J. B. Taylor, Signal Oil & Gas Co.; C. D. Gard, Union; W. W. Robinson, Jr., Texaco; William A. Kirk, California Southern Oil Co.

L.P.G., and as a blending agent for improving motor-fuel properties.

Operation efficiency.—E. G. Ragatz, associate of J. B. Gill Co., in discussing the efficiency of absorbers, concluded that absorption columns can be designed to operate at extraction efficiencies markedly in excess of the great majority of currently operating commercial units.

Other conclusions resulting from his studies, which centered around analyses involving the "straight-line absorption chart," were:

1. When recoveries of the order of 90 per cent or higher are desired, particularly in those cases where the component in question exists in considerable amount, employment of superefficient columns is highly profitable.

2. Design of such superefficient columns requires careful attention to the development of high individual-tray efficiencies.

3. The straight-line chart technique offers an effective tool for studying existing column operations whereby the various factors influencing tray efficiency may be evaluated and properly employed for the development of really high-efficient column designs.

How well perforated-plate tray towers have performed was covered in a paper by Harry R. Marsh of J. B. Gill Co., Los Angeles. Based on the performance of towers which have been in operation for 2 years or longer he believed: (1) that properly designed, the perforated-plate tray towers are as efficient in every respect as the conventional bubble-cap tray in common use; (2) they can be designed to operate over as wide a range of loading as conventional bubble-cap trays, and in some instances over a wider range with greater over-all efficiency; and (3) they are of extremely simple mechanical design, and plate material can easily be selected to meet corrosion and other special requirements.

Following a discussion of developments in gasoline-plant pumps, P. L. Armstrong of Union Steam Pump Sales Co., Los Angeles, had the following to say about future centrifugal pumps:

Higher speeds.—"It is possible, with the advent of the gas turbine and high-speed steam turbines, to operate centrifugals at much higher speeds, and we understand that one company is about to offer a special pump to operate at speeds up to 10,000 r.p.m. We should keep in mind, however, with our knowledge of fluid mechanics, that an increase in speed can only be obtained by an increase in suction pressure. So while it is possible to operate pumps at higher speeds, speaking for the natural-gasoline industry, it is neither practical nor economical to do so. . . .

"Without going into a discussion of the theory of centrifugal pumps, it is well to keep in mind there is a certain relationship between the capacity of a pump and the pressure which a pump will develop. This would seem to preclude the use of centrifugal pumps in normal gasoline-plant operations at speeds appreciably above 4,000 r.p.m. Remember, we are talking now about trends in the average plant, and not about what it is possible to do. So without limiting ourselves, we do not foresee any radical new designs. We do rather see a continual improvement both in mechanical features and hydraulic design."

When C.N.G.A. was formed at its first general meeting on December 2, 1925, these three men were its first officers (left to right): J. A. Campbell, of J. A. Campbell Co., Los Angeles, vice president; Paul Barton, Sun Oil Co., president; and J. S. Watson, California State Lands Commission, secretary.

NATIONAL AFFAIRS

Oil-Industry Steel

PAD tells NPA oil industry must have 1,947,000 tons of tubular goods for production, natural gasoline in 1951

Bertram F. Linz

WASHINGTON.—Reporting that the productive capacity of the domestic oil industry now is only about 250,000 bbl. per day above demand, the Petroleum Administration for Defense told the National Production Authority last week that a "concerted effort should be made immediately to increase our petroleum reserves to an adequate level."

To make this possible, PAD recommended that 1,947,000 tons of oil-country tubular goods be earmarked for production and natural-gasoline operations in 1951, 1,785,000 tons of it to enable the more than 10,000 domestic operators to drill the 43,400 wells estimated necessary to meet domestic and export requirements ranging from 7,000,000 to 7,100,000 bbl. daily, and 162,000 tons for use in foreign operations.

In addition, the report stated, 874,000 tons of line pipe will be required, and 992,000 tons of alloy and carbon-steel shapes and forms for petroleum-equipment manufacture.

PAD studies supplementing those of the National Petroleum Council and military and industry groups indicates that if imports average about 800,000 bbl. daily next year, a domestic supply of 6,300,000 bbl. daily must be provided.

"Experience has conclusively shown that to support this production it will be necessary to find and develop 4,576,000,000 bbl. of new reserves which on the basis of industry experience should require the drilling of 159,300,000 ft. of hole or 43,400 wells during the coming year," the report said. "This is a minimum required program consistent with the best interests of national security."

Emphasizing that if the 1951 drilling program is to be met the supply of oil-country tubular goods must be increased, PAD pointed out that the deficiencies between the 1950 production of material and its use were made up by operators only by following "unsound and uneconomic practices which cannot be pursued indefinitely."

New plants.—The report also disclosed that questionnaires sent to individual operators involved in natural-gasoline, recycling, and pressure-

WATCHING WASHINGTON

Bertram F. Linz

Good for Oil

The slim majorities which the administration will have in Senate and House next year will leave the responsibility for legislation in the hands of the Democrats, but the Republicans will have the last word on what is to be enacted.

For the oil industry, this situation is expected to be all to the good by strengthening the opposition to objectionable administration proposals. It may make little difference in the field of foreign policy, although Congress now may reexamine both the European Recovery Program and the Korean situation, the former with a view of lightening the burden of Economic Cooperation Administration assistance in the light of the great recovery made in many Marshall-plan countries and the encouraging prospects for the future, the latter to bring out any mistakes that may have been made and better evaluate the defense program.

In domestic matters, however, the stronger Republican minority will make difficulties for many of the administration's programs. Even with the substantial majorities the administration had in both houses this year, it is impossible to put over some of the Fair Deal ideas, notably federal administration of the tidelands. The 1951 Congress may go further than refusing new authorities to the Government; it may make a real effort to cut government spending which it is now estimated in some administration circles may run as high as $65,000,000,000 in the fiscal year 1952.

Who Will Lead?

One of the first problems the Democrats will encounter in January is that of Senate leadership. The defeat of Senate Leader Scott Lucas of Illinois and Majority Whip Francis Myers of Pennsylvania takes two of the President's stalwarts out of the picture.

Most seriously considered as successor to Lucas was Sen. Joseph C. O'Mahoney of Wyoming, sponsor of the Interior Department's $85,000,000 synthetic liquid-fuels program, author of legislation for federal administration of the tidelands, and a leader in oil legislation generally. Also mentioned was Sen. Clinton Anderson of New Mexico, former Secretary of Agriculture but opponent of his successor's plan for supporting farm prices.

But both O'Mahoney and Anderson have indicated they do not seek the job of leading Senate Democrats, throwing the field wide open for a contest which probably will be settled only when Congress meets. Parenthetically, Sen. Millard F. Tydings of Maryland is understood to have been selected to succeed Lucas if the latter was defeated but was himself knocked off.

As successor to Myers, Sen. Ernest W. McFarland of Arizona is considered a leading contender. McFarland, who has substituted for Lucas as leader upon occasion, is a member of both O'Mahoney's interior affairs committee and the interstate and foreign commerce committee of which Sen. Edwin C. Johnson of Colorado is chairman, and has maintained a friendly attitude toward the oil industry.

Committee Revamp

The lessened majority of the Democrats will necessitate the revamping of some Senate committees. The interstate commerce committee, now organized on the basis of eight Democrats and five Republicans, will have to be set up on a seven-to-six basis, but the Democrats lost one member of the committee in the defeat of Myers of Pennsylvania.

The interior affairs committee, already organized on a seven-to-six basis, is losing two members, Sen. Sheridan Downey of California who is retiring and Sen. Edward L. Leahy of Rhode Island, who was a temporary successor to former Senator and now Atty. Gen. J. Howard McGrath pending the election.

On the judiciary committee, another eight-to-five group, both parties lost one member, Frank P. Graham of North Carolina, Democrat, and Forrest C. Donnell of Missouri, Republican, being defeated.

There were no election casualties among the chairmen of the House committees which have an interest in oil. All of the Republican members of the interstate commerce committee were returned, but there will be four changes in the Democratic list.

The job of organizing the House will not be difficult, since both Speaker Sam Rayburn of Texas and Majority Leader John W. McCormack of Massachusetts were reelected, but as in the Senate the South will hold the balance of power.

maintenance operations developed that 38 new plants are now being built or definitely planned for construction next year which should increase daily production of natural gasoline by 31,500 bbl., butane by 18,600,000 bbl. and propane by 27,200 bbl.

The demand for petroleum products for national defense, domestic industry, European recovery, essential civilian, and other programs has increased since the end of the war at a rate which no one believed possible at that time, the report pointed out.

"The unprecedented demands for petroleum coupled with conditions over which the industry has had no control have not allowed it to maintain the reserve productive capacity with which it entered World War II.

"The ability to produce to meet increased future demands with adequate factors of safety depends largely upon systematically developing petroleum reserves considerably larger than those produced. Reserve development in turn is, as in the past, dependent upon the effort the industry exerts, the footage, and number of wells drilled."

Following PAD's recommendations, NPA has issued an order requiring steel producers to earmark supplies of oil-country tubular goods and other products for warehouses.

The order requires the producers to allot to their warehouse customers proportionate percentages of each steel product, based on average monthly shipments during the first 9 months of this year, in addition to shipments made to cover defense-rated orders held by warehouses, the allotments to come out of the production available after the mills have filled defense requirements.

At the same time, ceilings were established on the amounts of steel products for which warehouses are required to accept "DO" rated orders, to prevent the disruption of steel supplies to small operators.

In another order, designed to implement the new economic agreement with Canada *(The Oil and Gas Journal, November 2, 1950, page 38)*, the NPA provided for extension of the priorities system to Canadian firms doing defense work, to enable them to obtain needed materials from the United States. Canada, in turn, is extending its priority system to give U. S. manufacturers priority access to needed materials available in Canada.

Profits tax. — Meanwhile, the tax phase of the defense program was revived this week with the opening of hearings by the House ways and means committee precedent to writing an excess-profits tax bill.

The major question before the committee was not whether such a tax should be imposed but the form it should take. There is some question,

however, whether the bill will be enacted before the present Congrss expires at the turn of the year or simply be written and left for the consideration of the new Congress which takes over January 3.

Other congressional committees also are preparing to return to work with the meeting of the "lame duck" session, among them two Senate committees which, respectively, are making an investigation of all fuels and a study of New England's fuel supply.

PAD financed.—The Petroleum Administration for Defense has finally been financed by an allotment by the Budget Bureau of $275,000 for operations to December 31. J. Terry Duce of Arabian American Oil Co., Ltd., has joined the staff as consultant of foreign operations and further appointments are expected to be made in the next few weeks to fill the top posts in several divisions.

Meanwhile, discussions are continuing between Interior and NPA officials over the handling of allocations of petrochemicals. The PAD does not want the job of allocating products to other industries, and NPA officials have indicated that in no event will they give Interior any rating authority, but does feel that it should have jurisdiction over chemicals produced from oil and used chiefly within the oil industry.

Sulfur shortage. — Possibilities of a new shortage which might affect the oil industry developed this week, this time in sulfur. A recent survey of the world sulfur situation indicates that current annual production is about 5,700,000 tons and demand about 6,000,000 tons, with North America producing about 5,000,000 tons and consuming some 4,500,000 tons. The U. S. production includes not more than 200,000 tons recovered as a byproduct from sour gas.

While there is an apparent excess of supply over demand in the United States of around 500,000 tons, the threat of shortage comes from the fact that we are exporting more than 1,000,000 tons a year. The stake of the oil industry in this situation is shown by the fact that it consumes 1,200,000 tons a year, as against 750,000 tons in 1939.

Exports reviewed.—Government officials are now reviewing the export program with a view of its reduction. Spokesmen for agriculture, which consumes 3,700,000 tons a year, are urging a 50 per cent cut-back in exports, but this is opposed by the State Department and Economic Cooperation Administration as conflicting too severely with commitments under the European Recovery Program. The most that is now expected is a cut of around 30 per cent in the export quota.

GULF COAST

Field Allowable Cut

JACKSON.—A drastic reduction in the allowable oil production for Brookhaven field of Lincoln County was ordered last week by the Mississippi Oil and Gas Board.

Effective November 1, the allowable was lowered from the previous figure of 150 bbl. per day per well to 90.6 bbl., cutting the field total to 13,625 bbl. per day. The new figure will remain in effect through April 1951.

Currently, there are 150 producing oil wells in Brookhaven field, of which 149 are operated by the Brookhaven Unit account of The California Co. Sun Oil Co. 1 W. T. Smith, the remaining well situated outside the unit, received an allowable of 125 bbl. per day for the next 6 months.

The board also ordered a reduction in the allowable production figure for Mallalieu field of Lincoln County, where output was cut from the previous figure of 150 bbl. per day per well to 125 bbl. for the next 6 months.

The combined petition of Humble Oil & Refining Co. and Vaughey & Vaughey for the unitization of acreage surrounding the latter's 2 Board of Superivsors well in Carthage Point field of Adams County was granted by the board in order that this well might receive a full allowable for a complete unit of 320 acres. The newly established unit includes 136.83 acres held by Humble in the south half of Section 4-6n-4w, and 183.17 acres owned by Vaughey & Vaughey in the south half of Section 3-6n-4w.

November gas allowables were set for six fields as follows: Baxterville 2,332,000 M.c.f.; Gwinville 6,397,093 M.c.f.; Carthage Point 480,000 M.c.f.; Soso 892,293 M.c.f.; Sharon 420,000 M.c.f.; and Sandy Hook 23,671 M.c.f.

A. & I. Gets Accreditation

KINGSVILLE, Tex.—Full accreditation in petroleum and natural-gas engineering has been awarded Texas A. & I. College by the Engineers' Council for Professional Development, E. H. Poteet, president of the college, announced last week.

The Engineers' Council is a conference of eight major organizations formed to set up professional standards for colleges of engineering which will insure a sound educational background for their graduates.

The accreditation will mean that A. & I. graduates in natural-gas engineering will be fully recognized in all states and can better meet requirements for receiving state professional engineers' licenses.

Natural-gas engineering was added to the A. & I. course of study in September 1935.

ECONOMICS

Imports Drop

September figure down from August; exports up

IMPORTS of crude and petroleum products during the month of September averaged 818,000 bbl. daily, according to data of the Department of Commerce. This represents a decrease of 18,000 bbl. daily from the August average but is 158,000 bbl. daily greater than September imports last year.

Crude imports were off only 14,000 bbl. daily from the July average with the losses in receipts from Venezuela and Saudi Arabia almost offset by gains for Mexico, Colombia, and Kuwait. Crude imports from Venezuela were near the level of September 1949.

Product imports averaged 334,000 bbl. daily compared with 338,000 bbl. daily in August and 249,000 bbl. daily in September 1949.

Exports gained 30,000 bbl. daily over August to 280,000 bbl. daily with most of the increase credited to gasoline. Crude, distillate, and residual declined slightly. More lube oil was exported in September than in any other month this year.

IMPORTS INTO CONTINENTAL UNITED STATES
(Thousands of barrels)

	Sept. 1950	Aug. 1950	Sept. 1949
Mexico	1,065	794	633
Colombia	1,448	1,344	994
Venezuela	8,669	10,154	8,719
Kuwait	2,488	1,949	1,782
Saudi Arabia	863	1,185	220
Total crude	14,533	15,426	12,348
Daily average	484	498	411
Products—			
Residual fuel	8,918	9,105	7,081
Other products	1,087	1,371	380
Total products	10,005	10,476	7,461
Daily average	334	338	249
Total all oils	24,538	25,902	19,809
Daily average	818	836	660

EXPORTS*
(Thousands of barrels)

	Sept. 1950	Aug. 1950	Sept. 1949
Crude	2,654	3,096	2,619
Gasoline	1,849	982	2,248
Distillate	905	806	614
Residual	802	1,221	514
Lube oils	1,281	1,101	887
Other products	914	539	626
Total all oils	8,405	7,745	7,508
Daily average	280	250	250

*Excludes shipments to territories.

XUM

Alberta Activity

Canada's entire economy being changed by province's oil development; hearings under way to assess gas potentials

Kenneth B. Barnes

CALGARY.—The entire economy of Canada is being changed by Alberta's booming oil development and the Interprovincial oil pipe line spreading eastward across the continent, and a visit to either Calgary or Edmonton will furnish convincing evidence that western Canada is today the busiest spot extant in the search for new oil reserves. The total play all told spreads out over an expanse of territory of some 600,000 sq. miles.

Both Calgary and Edmonton are the "oil cities" in the Canadian oil search. Calgary, with a population of about 125,000, is the headquarters for some 55 American oil companies and many independents. It is the headquarters of the Western Canada Petroleum Association, and the Calgary Petroleum Club. Edmonton, 191 miles north, is the center of oil activities in the province and the center for equipment supplies and services. Edmonton, with a present population of 140,000, is the seat of the provincial government and the site of a modern and rapidly expanding provincial university (which recently graduated its first group from the new petroleum engineering department).

Natural gas.—Presently occupying attention of the oil industry are hearings now under way in Calgary by the Alberta Petroleum and Natural Gas Conservation Board, which are being held to determine Alberta's potential gas reserves and deliverability, and to assess the province's own gas needs, both present and future.

During these hearings, a number of well-known natural-gas economists and industry leaders have presented testimony.

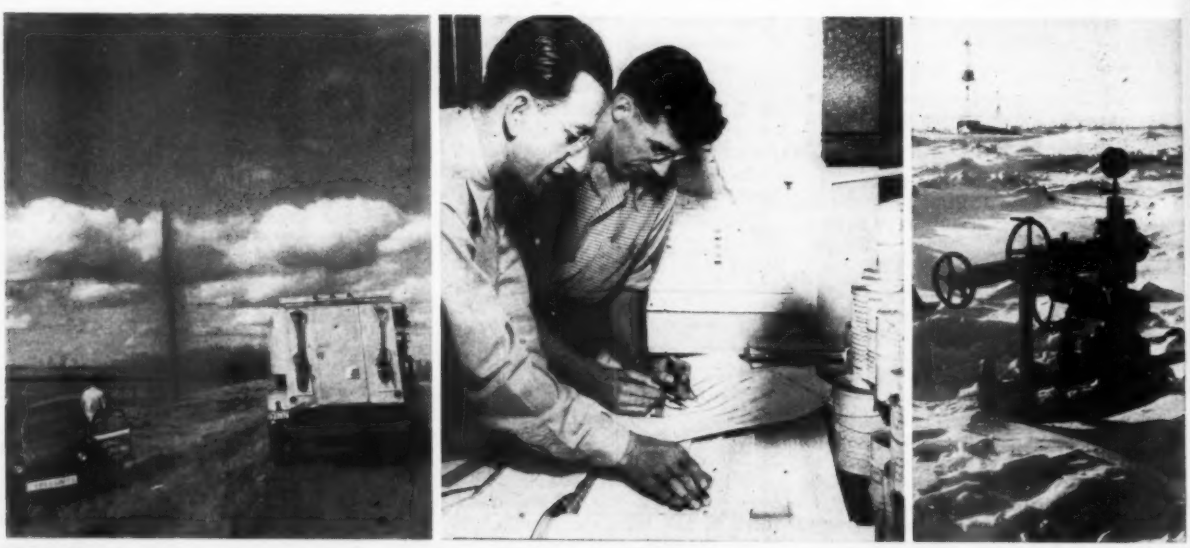
F. A. Brownie, Calgary, president of Canadian Western Natural Gas Co., Calgary, and Northwest Utilities, Edmonton, largest distributors in the province, reported that a careful analysis of annual market requirements and peak-day loads to 1980 showed that Canadian Western would require an estimated 1,064 billion cubic feet of gas to meet the estimated needs for the next 31 years, while Northwest would require an estimated 1,185 billion cubic feet, a total of 2,249 billion cubic feet for both firms.

Brownie said that in making his calculations he has not taken into consideration any suggested dispersal of war industries, now located in eastern Canada and the United States, but that the figures only included the requirements of smaller companies operating at Medicine Hat, Vermillion, Leduc, Wainwright, and other areas.

A New York natural-gas consultant, Ralph E. Davis, estimated reserves available to the two companies as of January 1, and their requirements to the end of 1980. Canadian Western at present, he said, had potential reserves of 490 billion cubic feet, and that estimated requirements were 1,064 billion cubic feet. He said present sources would only be adequate for about 10 or 12 years, and that there must be added to the system reserves of at least 750 billion cubic feet within the next 10 years if possible.

Northwest's requirements, he said, will be 1,185 billion cubic feet to 1980, and placed the gas economically available at 1,122 billion cubic feet. Substantial reserves should be acquired by the company, he reported, not later than 1960 to add at least 550 billion cubic feet to the reserves until gas becomes available from the Leduc area.

Consumption estimated.—William A. Lang, Edmonton, secretary of the Research Council of Alberta, estimated that consumption of natural gas in the province during the next 50 years would increase four-fold of the present requirements, and Ben Russell, Edmonton, chairman of the Alberta Power Commission, said that by 1960 an estimated 20,000,000 cu. ft. per year would be required for the generation of electric power. He said that electric-power demand was steadily increasing, and that, as there was a limit to the development of cheap power, it might be considered advisable to regulate the price of gas for power generation at a low figure. He estimated that by 1960 there would be an annual demand for 1,855.5 million kilowatts of power, of which



THREE STEPS.—Seismic shooting, interpreting records, producing oil. While by no means the work or results are that simple, it is a fact that western Canada's 600,000 sq. miles of prospective territory are now going through the greatest oil-exploration search and land boom in its history.

about 700,000,000 kw. could be provided by additional hydropower, coal, and diesel plants, to leave 1 billion kilowatts to be generated with natural gas.

Marketable gas.—Gas experts engaged by McColl-Frontenac Oil Co., Ltd., and Union Oil Co. of California, estimated Alberta's marketable natural gas recoverable from 44 proven fields to be 6,283 billion cubic feet, of which 5,589.7 billion cubic feet, obtainable from 26 fields, was within economic reach of a market, pipe line, or practical grid system. The two companies are seeking permission to export gas from their own fields in southeastern Alberta, through a 70-mile pipe line to the already established natural-gas pipe-line system of Montana Power Co.

Dr. Hugh B. Beach, Calgary, and John F. Dodge, Los Angeles, also submitted figures to the board.

Dr. Beach said that he had data on 75 areas and estimated that a total of 7,753 billion cubic feet of gas was stored in 44 proven fields, of which 6,283 billion cubic feet would be marketable. Dodge said that 13 of the proven fields would provide an estimated 4,802.4 billion cubic feet of gas to provide for all present and future needs of the two large distributors, namely Canadian Western and Northwestern Utilities.

Sees ample supply.—A. Fasion Dixon, New York, president of Northwest Natural Gas Co., said that Alberta's present wells would supply enough natural gas to: provide for the "highest estimate" of Alberta's needs for 30 years, provide 80 billion cubic feet per year for export for 20 years, and still leave 1,5 trillion cubic feet in those present wells.

Northwest Natural and its associate, Alberta Natural Gas Grid, Ltd., propose to gather gas from Alberta fields and make it available for domestic consumption, and also to export 219,000,000 cu. ft. daily, via Kingsgate, B. C., to be delivered at Trail and Vancouver, both in British Columbia, and to Spokane, Seattle, and the Atomic Energy Commission plant at Hanford, all in the State of Washington.

(Westcoast Transmission Co., Inc., affiliate of Westcoast Transmission Co., Ltd., last week filed an application with the U. S. Federal Power Commission for authorization to construct and operate a pipe line for transportation of natural gas to Washington and Oregon.) *(See page 370 of this issue.)*

Petrochemicals.—J. R. Donald, O. B. E., Montreal chemical engineer, told the board that a capital investment of $150,000,000 in chemical industries could be envisioned for Alberta, provided raw material and natural-gas reserves for a period of 25 years and longer were assured.

He said that Alberta's position in Canadian economy was unique, its resources were varied and extensive, and it was the only province with substantial reserves of petroleum and natural gas.

"If Alberta gas were available in the United States at low prices," he said, "it would permit the creation of a petrochemical industry based on this gas. Alberta would lose the advantages which would accrue if the petrochemical industries were located in Alberta and the product shipped to the United States."

TECHNOLOGY

Motor-Fuels Study

S.A.E. group reviews data on aircraft and diesel fuels, antiknock progress, use of L.P.G. products in motor buses

R. B. Tuttle

IMPROVEMENT of fuel systems of small aircraft as a safety measure, and the possibilities of utilizing liquefied petroleum gas as fuel in motor buses were among topics discussed in Tulsa last week by petroleum and automotive engineers attending a 2-day national fuels and lubricants meeting of the Society of Automotive Engineers.

Survey data also were reviewed concerning fuel antiknock requirements of passenger cars and the fuel needs of small privately owned aircraft, with emphasis on use of fuels and fuel systems which prevent or discourage vapor-locking troubles.

Diesel fuel.—Addition of ignition-quality improvers to diesel-engine fuels is a mixed blessing, W. E. Robbins, R. R. Audette, and N. E. Reynolds, III, of the U. S. Naval Engineering Experiment Station, told the group, because while the cetane number of lower-grade fuels may be increased, difficulties are encountered with instability, piston-ring sticking, and other developments. They said that certain additives help improve diesel fuels used in low-temperature areas, and reported that certain additives have shown the possibility of increasing cetane numbers by 20 or more units.

Test engine.—W. F. Ford and O. L. Spilman, of Continental Oil Co., reported that the engine from the "Farmall Cub" tractor had been found satisfactory for pilot-testing fuels and lubricants and assures good correlation with accepted full-scale gasoline-engine tests. The flexibility of the engine is such, they added, as to offer a wide range of operating conditions so that fuels and lubricating oils may be tested under differing circumstances, and also permits prediction, with accuracy, of the performance of fuel or lubricant in full-scale engines under given conditions.

Electronic road load.—Development of an electronic-dynamometer control which automatically imposes upon laboratory-mounted engines the same loads that the engines would encounter in vehicles was described by A. R. Isitt, M. R. Wall, and A. G. Cattaneo, of Shell Development Co. They pointed out that knock-testing of fuels is difficult on the highway because of traffic conditions and other factors beyond control, but that by using an "electronic-road load" (ERL) it is possible accurately to simulate road conditions of operation without the annoyance of traffic hazards, wind noises, changes in paving and grade, or other difficulties.

"The usefulness of ERL control is not limited to fuel rating," they said, "but may be extended, by the use of an automatic throttle control, to provide any cycle of operation for studies of engine deposits and wear. Since the ERL control automatically applies a road load corresponding to a given throttle setting, or change in throttle setting, it permits the use of a relatively simple throttle program timer to duplicate any desired operating cycle."

Small planes.—Plea for making such mechanical changes in the fuel systems of small planes as to assure freedom from the dangers and difficulties of vapor lock was voiced by L. L. York, of Continental Motors Corp., and A. Hundere, of California Research Corp. All parts of the fuel system should be kept at minimum temperature and maximum pressure.

Variations in the carburetors of engines in small planes can affect the octane requirements of fuel from four to six octane numbers and fuel consumption about 50 per cent, V. E. Yust, of Shell Oil Co., reported. Variations in spark timing and adjustment of cooling-air baffles also affect engine performance, he said, while the combined influence of such variables is sufficient to increase fuel-octane requirement by as much as 16 octane numbers and fuel consumption by 70 per cent. Use of the new 87-grade aircraft fuel, he commented, should minimize the possibility of detonation and engine failure.

W. V. Hanley, Standard Oil Co. of California, told the S.A.E. that:

1. Currently used personal-plane aviation gasoline marketed by the major suppliers performs well in present-day personal planes with the exception of detonation in some cases.

2. Personal-plane 80-octane aviation gasoline should have a minimum rich takeoff octane number of 87 (F-4 method).

3. Uncompounded oils are inadequate in personal-plane engines for maximum operating time between overhauls under severe operating conditions.

4. New-type additive oils which cannot cause preignition are being developed and will provide cleaner engines and longer overhaul times than have generally been experienced in the past.

Antiknock.—Tetraethyl lead seems to offer the most reliable potentialities for improving motor-fuel antiknock qualities, the meeting was told by H. E. Hesselberg and W. G. Lovell, of Ethyl Corp. Describing a series of tests of engines variously equipped for supercharging and for high-compression ratios, they commented that the goal of knock-prevention seems always to demand a compromise between engine power and economy. Their conclusions in part were:

"Fuel consumption is determined primarily by compression ratio (other factors being constant) and for varied compression ratios with a fixed-engine design at given operating conditions is substantially proportional to a constant fraction of air-cycle efficiency.

"Absolute values of power output obtainable with a given fuel vary with engine design and represent a compromise between desired economy and desired power.

"For the paraffins and naphthenes the effectiveness of tetraethyl lead in increasing antiknock quality is, in general, a constant per cent of the performance number of the base fuel.

"With 'sensitive' fuels it has been found that factors of engine design and changes in engine operating conditions greatly influence their relative ratings. In general, the effectiveness of tetraethyl lead in these fuels is much greater under mile-engine conditions."

A comprehensive report on a survey of the antiknock requirements of passenger-car fuels was made jointly by H. W. Best, of Yale University; H. J. Gibson, of Ethyl Corp.; and J. E. Taylor, of Gulf Oil Corp. They said that the spread in fuel requirements, based upon changes in spark advance within automobile manufacturers' tolerances, amounted to as much as 23 octane numbers, ranging from a maximum of 93 to less than 70. About 50 per cent of automobiles in service proved, when tested, to knock on motor fuel found in their tanks, it was reported, and difficulties with knocking were ascribed chiefly to differences in ignition timing and to chamber deposits in engines.

L.P.G. power.—Bus operators are showing an increasing interest in the use of liquefied petroleum gas as a fuel to be used instead of gasoline, Dr. Leonard Raymond of Socony-Vacuum Oil Co., Inc., said. Conversions to L.P.G. also have been made on heavy trucks, off-the-road vehicles, rail cars, and industrial engines. California is making the largest use of L.P.G. in internal-combustion engines, with an estimated 2,000 truck and 20,000 pieces of farm and highway-construction equipment in the state being run on bottled gas. About 3 per cent of L.P.G. sold in the United States is for automotive use.

In the Southwest and Middle West states surrounding the L.P.G. producing area, L.P.G. is expected to make considerable inroads in the farm tractor field, Dr. Raymond predicted. He pointed out that one company estimates that 30,000 tractors will be converted to L.P.G. fuel this year.

EASTERN

New England Gas

FPC solves problem of natural-gas supply by splitting market between Northeastern and Algonquin companies

WASHINGTON.—The Federal Power Commission solved the problem of New England natural-gas supply last week by splitting the market between Northeastern Gas Transmission Co. and Algonquin Gas Transmission Co., in apparent contradiction to the position it took October 4 when the applications of both companies were rejected on the ground that needless duplication and overlapping of facilities would place an unjust and unnecessary financial burden upon consumers *(The Oil and Gas Journal, October 12, 1950, page 57; October 19, 1950, page 61)*.

The commission's order was definite only with respect to Northeastern, Algonquin not yet having submitted evidence on its gas supply, and included an authorization to Tennessee Gas Transmission Co. to carry out a $118,643,545 expansion program to supply a portion of the natural-gas requirements of Northeastern, a subsidiary.

The commission also authorized Transcontinental Gas Pipe Line Corp. to extend its system to the New York-Connecticut state line in order to supply part of Northeastern's natural-gas needs, and New York State Natural Gas Corp. and Niagara Mohawk Power Corp. to build pipeline facilities in New York State to handle gas to be supplied by Tennessee.

Under the order, Northeastern will serve certain markets in Massachusetts, Connecticut, and southern New Hampshire. The remaining markets in Massachusetts and Connecticut, all of Rhode Island, and one company in New Jersey are reserved for Algonquin. No provision is made for the northern part of New Hampshire or for Maine or Vermont in the order.

Requirements.—The commission reported that the total estimated requirements of the companies Northeastern is to serve will amount to 47,000,000 M.c.f. a year by 1956; with a peak-day requirement of 207,000 M.c.f., of which Tennessee will supply 156,000 M.c.f. and Transcontinental 64,000 M.c.f. The markets to be served by Algonquin will have a 1956 requirement of 40,000,000 M.c.f. and a peak-day load of 184,000 M.c.f.

The Northeastern authorization requires that the company shall establish interconnections and enter into agreements for emergency interchange of gas with any system or systems serving the New England area at wholesale, and will file, prior to the commencement of construction, a plan of financing, and, before operation, a natural-gas tariff satisfactory to the FPC. The company is given 30 days within which to accept the certificate.

T.G.T. project.—The T.G.T. project authorized will increase the company's capacity by 250,000 M.c.f. daily to a total of 1,310,000 M.c.f. a day, and includes a 303-mile main-line extension from the eastern terminus of its already authorized Kentucky-Buffalo pipe line to a connection with Northeastern's facilities at the Massachusetts line. The company also may build approximately 786.6 miles of loop line along its existing or authorized line between Texas and Buffalo, install 69,600 hp. of new compressor units in existing or authorized stations and 42,080 hp. in seven new stations, and construct about 75 miles of lateral gas-supply lines.

Transco.—Transcontinental is authorized to build 35.5 miles of 24-in. line from Bergen County, New Jersey, to Greenwich, Conn., together with a 6,000 hp. compressor station, and an 8-in. lateral to serve Paterson, N. J., at an estimated cost of $6,504,-

000. This authorization, however, is subject to final action on certain substitutions presented by the company in an application now pending.

N. Y. Natural.—New York State Natural will build 164 miles of 16-in. line from Dryden to the Albany area; a 56-mile line from the Dryden terminus to a storage pool in Tioga County, Pennsylvania, and other facilities to develop a new storage pool, at an estimated cost of $13,118,000. Niagara Mohawk will construct some 25.7 miles of line to connect with New York State Natural at three points at an estimated cost of $1,342,000.

A partial dissent from the commission's order was filed by Com. Thomas C. Buchanan, who asserted it left unanswered several questions regarding Algonquin's position and deprives that portion of New England not to be served by Northeastern "of the instrumentality through which that area would receive natural-gas service eventually by the quickest and most available means."

Maryland Gas

Discovery spurs Deer Park structure activity

Polly DeArmond

AN important wildcat in the extreme southwestern part of Garrett County, Maryland, has found gas production on the Deer Park structure, a long, sharp, anticlinal fold extending from West Virginia through the corner of Maryland into Pennsylvania.

This newly opened producing area is thought to be on the upthrow side of a fault of considerable magnitude as yet unrevealed in surface geology, and has consequently spurred exploration in the region.

Columbian Carbon Co.'s success, 1 N. K. Welch, is located on the Oakland Quadrangle, 2.4 miles south of Lat. 39° 25′, and 3 miles west of Long. 79° 20′, southeast of the town of Oakland and south of Mountain Lake Park. At present several wells are planned within the limits of the latter town.

The Welch discovery struck gas at 2,835 ft. in Huntersville chert, and was completed at 2,869 ft., with the gas increasing to that depth. Final test was an open flow of 8,029,000 cu. ft. of gas, natural, with rock pressure of 1,610 psi. Top of the chert was called at minus 408 ft., being 1,533 ft. higher structurally than Cumberland & Allegheny Gas Co.'s S-424 E. N. Beachy, previous small gas find 4½ miles to the southwest.

Columbian originally scheduled the Welch as a deep test, and started operations in August. Its completion at a shallow depth marks the first sizable gas discovery in Maryland.

Previous drilling.—The first deep test in this general vicinity was Columbian Carbon 1 Durr, approximately 3 miles southwest of the Beachy well and 7½ miles southwest of the Welch test. This well had a show of gas in the Huntersville chert, top of which was logged at minus 2,012 ft., but was completed dry at 5,259 ft.

The second well, the Cumberland & Allegheny Beachy discovery, has been producing gas into pipe line since completion in November 1949. It topped the Huntersville at minus 1,941 ft., and had open flow of 582,000 cu. ft. of gas from the chert at 4,454-56 ft. Total depth was 4,910 ft., and rock pressure was 1,600 psi.

Current activity.—Fox & Trimble 1 Edward Kite, about 1 mile northwest of the Beachy producer, resulted in salt water at 5,019 ft., with a show of gas in the chert topped at 4,708 ft. (or minus 2,183 ft.). Eberly & Snee 1 G. H. Blocher, in the same area, had hole full of water at 5,136 ft., ran low to the Kite well on the chert, and encountered no shows.

At the end of the second week in November Columbian Carbon Co. was drilling below 1,200 ft. in the 1 O. T. Grasser, less than ½ mile east of the Welch well. The company has another drilling venture under way, and other operators have started an additional three operations.

Secondary Recovery

Improved methods are reported in Pennsylvania

STATE COLLEGE, Pa.—Experiments with long samples of oil-bearing formations have indicated that petroleum recovery by secondary methods may be increased up to 54 per cent by the establishment of a high free-gas saturation in the core after the primary production phase, and just prior to the initiation of the water flood.

The results of these experiments were disclosed in a paper by Dr. J. N. Breston, Joseph Saxon, Jr., and R. M. Macfarlane, of the production-research laboratory, Pennsylvania Grade Crude Oil Association, at the fourteenth annual secondary recovery conference sponsored by the Pennsylvania State College School of Mineral Industries, held here November 9-11.

The paper explained that increased oil production was caused mainly by an effective gas drive operating ahead of the water flood. The gas drive caused a thorough oil removal over the whole core but still left it in condition for further recovery by water flooding. Furthermore, the free gas acts as a temporary selective-plugging agent just ahead of the water thereby preventing it from channeling or moving too fast in the larger pores. When nitrogen (only slightly soluble in oil) was substituted for natural gas an increased recovery was also obtained indicating that the increased recovery of oil was more related to the content of free gas than the dissolved gas. The experiments indicated that in addition to making the flood more efficient, free gas also takes the place of residual oil.

Other papers.—Other interesting technical papers, all aimed directly or indirectly toward the ultimate recovery of our "lost" reserves, were presented at the conference.

P. W. Sturm and W. E. Johnson, Pennsylvania Grade Crude Oil Association, reported that fluorescein, a yellow chemical dye, had been found advantageous when mixed with water injected into oil formations as a tracer in detecting such conditions as crevices, fissures, or very loose sand that are adverse to oil-producing efficiency. Field experiments also found that other fluorescent dyes, salt, and wetting agents were also useful for this purpose.

New and improved methods for increasing the productive life of a water-flooded field were reported by H. H. Danielson, South Penn Oil Co., and Don Martin, Hercules Powder Co. They reported the economic advantages resulting from a long-range field study including an improved method of applying the plugging agent, the use of pressure dissipation as a method of determining the effectiveness of the plugging performance, and techniques for analyzing wells of high-input rates.

Plugging technique.—Additional work to improve the technique of placing the plugging agent in an injection well in a manner that will reduce bypassing of injected gas was indicated by experimental work reported by Paul T. Bail and Charles E. Whieldon, Jr., United States Bureau of Mines Station, Franklin, Pa.

Papers by the Pennsylvania State College staff discussed various aspects of mineralogy (core orientation), and geophysics connected with petroleum production and the technology of fluid displacement.

One paper discussed the relative wettabilities of cores to oil and brine. Curves for displacement of oil by brine and brine by oil were obtained for a number of Bradford, Venango, and Chipmunk cores. These curves were discussed in relation to wettability properties, saturations, and previous treatments.

International news in this issue of the Journal will be found on pages 408-409.

XUM

Steps Up

Kyle named vice president of Michigan-Wisconsin

VOLNEY H. KYLE, JR., has been named vice president and manager of operations for Michigan-Wisconsin Pipe Line Co., an affiliate of Michigan Consolidated Gas Co. and Milwaukee Gas Light Co. in the American Natural Gas Co. System.

As an engineer on the staff of Ford, Bacon & Davis, Kyle had the responsibility in the field for construction of Michigan - Wisconsin's recently completed 1,500-mile natural-gas system which carries gas from Texas to the states of Michigan and Wisconsin. He was with Ford, Bacon & Davis until he joined Michigan-Wisconsin in January of this year.

Kyle is a native of Houma, La., and majored in mechanical engineering at Tulane University.

He is a pioneer in the natural-gas-transmission business, having assisted in the construction in 1927 of one of the first large-diameter cross-country high-pressure natural-gas pipe lines ever built—from Monroe, La., to Baton Rouge and New Orleans. This particular line was built by Ford, Bacon & Davis for Interstate Natural Gas Co., Inc.

M. M. Jameson, chief engineer for Milwhite Co., Inc., has been transferred from Tuckahoe, N. Y., to Houston.

Harold Kane Greenleaf, Corpus Christi, and **Earl Baldridge,** McAllen, Tex., both vice presidents of the Chicago Corp., have moved to Fort Worth, and will be in charge of the company's newly created land, geological, and exploration office there.

B. F. Rummerfield, graduate of the Colorado School of Mines, has been appointed manager of seismic operations for Century Geophysical Corp., Tulsa. Before joining Century he was assistant manager and geophysical supervisor for Seismic Service Corp. in Mexico.

Edward C. Ritchey, formerly of Norman, Okla., has joined Kerr-McGee Oil Industries, Inc., at Oklahoma City, as research chemical engineer.

William D. Morris, Fort Worth, has resigned as secretary-treasurer of J. C. Maxwell, Inc., and Worth Drilling Co., Inc., to devote his time to Whaley Co., Inc., of which he is president.

Arnold G. Shipp has been named assistant treasurer of Tide Water Associated Oil Co.'s eastern division in New York, succeeding **Samuel J. Kane** who has retired.

James P. McGovern has been named assistant regional engineer in the mechanical department at Esso Standard Oil Co.'s Bayway refinery, Linden, N. J. Other changes include: **Pietro DiDonato, Frank J. Rupp,** and **Walter Milos,** named zone foremen.

Ben H. Ploch, geological scout for Skelly Oil Co. at Evansville, Ind., has been transferred to Jackson, Miss.

Andros Guilde, consulting geologist, has moved his offices from Carmi to Evansville, Ill.

R. E. Dobyns has been appointed crude-oil representative for the Houston area of Shell Oil Co. He will work in coordination with **O. D. Crites,** regional crude oil manager in Houston for Shell's East of the Rockies territory.

Dr. Robert B. Killingsworth, assistant director of the technical service department, Brooklyn, for Socony-Vacuum Oil Co., Inc., has been transferred to the headquarters staff of Socony-Vacuum Laboratories, a division of the firm. He started with the company in 1937 as a chemist.

T. O. Williams has been elected assistant secretary of Gulf Oil Corp. and Gulf Refining Co.

Rupert Cox has been transferred from Corpus Christi to San Antonio in charge of the Dan L. Clark Drilling Co.'s newly opened office.

Edward B. Swanson, assistant director of the Oil and Gas Division, has been awarded the Interior Department gold medal for distinguished service, for the outstanding accomplishments during the 30 years he has been in the department's service.

Edwin C. Aldrich, junior engineer for Carter Oil Co., has been transferred from Seminole, Okla., to Carmi, Ill.

W. O. White, Shreveport, has resigned as executive vice president of Ormond Corp. and will become president of Kenilworth Oil Corp., a new firm devoted to exploration and development, with offices in Dallas, Magnolia, Ark., and Shreveport.

Wayne Granger, formerly development geologist for the Midland, division of Standard Oil Co. of Texas, has joined Brinkerhoff Drilling Co. as geologist.

F. M. Willenburg, formerly assistant division manager at Shawnee, Okla., for Service Pipe Line Co., has been transferred to Fort Worth as Central and East Texas division manager succeeding **J. J. Hill,** who has retired.

W. E. V. Abraham, managing director of Burmah Oil Co., Ltd., London, visited in Tulsa last week en route to the annual meeting of the American Petroleum Institute where he presented a paper. Abraham will visit additional points in the United States before returning to London.

J. W. C. McKee, independent oil producer, has moved from Mount Pleasant to Grand Rapids, Mich.

C. C. Austin, Shell Pipe Line Corp., has been named station engineer at Healdton, Okla. Other changes include: **T. L. Brodie,** station engineer at Kilgore, Tex., to assistant station chief engineer at Huffman, Tex.; **K. C. Cooley,** junior engineer to engineer at Houston; **S. B. Elenberg,** station engineer, transferred from Yarna to Bland, Mo.; **O. G. Harvey,** station engineer at Hamlin, Tex., to chief engineer at Huffman; **C. C. Kaegi,** gager, transferred from La Gree to Wood River, Ill.; **O. G. McVicker,** station engineer, transferred from Cushing, Okla., to Chelsea, Okla.; **E. D. Otis,** gager, transferred from Houston to Fredericksburg, Tex., as station engineer; **R. W. Parks,** gager, transferred from LaGree to Wood River; **T. H. Price,** gager, transferred from Eunice to Hobbs, N. M.; **L. L. Taylor,** gager, transferred from Houston to Kilgore as station engineer; and **E. R. Watson,** field gager, transferred from Hobbs, to Hamlin as station engineer.

PERSONALS

J. F. Lanthrip, chief of the budget section for British-American Oil Producing Co., has been named assistant treasurer.

James Helis, assistant division drilling superintendent for Atlantic Refining Co. at Corpus Christi, has been transferred to Tulsa.

M. P. Jones, formerly consulting geophysicist at Dallas, has joined Crown Central Petroleum Corp. at Houston, as chief geophysicist.

J. P. Williams, The California Co., has been elected president of the Shreveport Oil Scouts Association, succeeding W. N. O'Roark, Carter Oil Co.

Sloan Paxton, district manager of Southern Union Gas Co., Pecos, Tex., has been elected district governor of Rotary International.

Ray W. Winters, West Texas division geologist for Richardson & Bass at Monahans, has been transferred to New Orleans as district geologist.

Lebert J. Williams, compressor-station superintendent for Transcontinental Gas Pipe Line Corp. at Billingsly, Ala., has been transferred to Tylertown, Miss.

Tom Gaines, district petroleum engineer at El Campo, Tex., for The Texas Co., has been transferred to the Rocky Mountain division at Denver as assistant division petroleum engineer. **John F. Blair,** geophysical party chief, has been transferred from Roswell to Portales, N. M.

R. C. FREDERICK

R. C. Frederick, Gulf Oil Corp., has been appointed chief of the gas-supply and disposition branch of the production department staff in Pittsburgh. He joined Gulf in 1927, after graduating from Denison University. **Carl J. Maki** has been appointed assistant to Frederick. He was originally employed by Mene Grande Oil Co., Gulf subsidiary, in 1945 to form the gas department, and served as superintendent of that department in eastern Venezuela until his new appointment.

Jesse L. (Red) Hill, stillman at The Texas Co.'s refinery at San Antonio until that plant was shut down, has joined E. I. du Pont de Nemours & Co., Inc., as an operator on the company's Victoria, Tex., petrochemical plant. Hill had been with Texaco for 15 years, working up through the ranks to stillman. Since joining du Pont, he has worked in the sodium cyanide, inert gas, compressor, and chlorination sections of the Victoria plant.

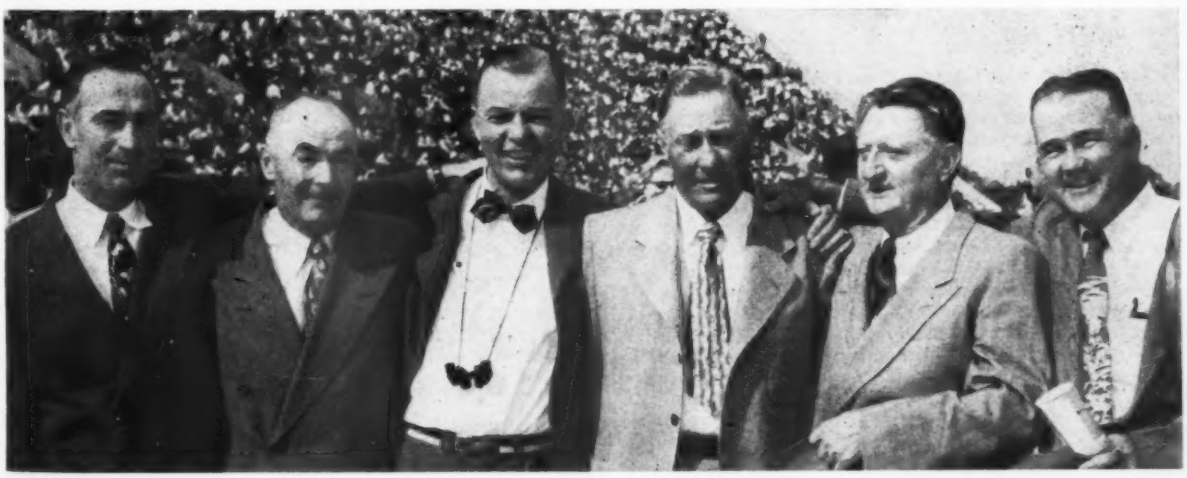
Thomas C. Mann, of Laredo, Tex., in charge of petroleum and political affairs at the American Embassy in Caracas, Venezuela, from 1947 through 1949, and since then director of the office of Middle American Affairs in the State Department Bureau of Inter-American Affairs, has been appointed deputy assistant secretary in the bureau.

Kenneth E. Meyer, production engineer at Fort Worth for Petroleum Advisers, Inc., an affiliate of Cities Service Co., has been transferred to New York City as petroleum engineer.

T. E. Ockershauser, Oklahoma City, has resigned from Globe Oil & Refining Co. after 3 years as engineer in charge of the Southwest Antioch Gibson Sand Unit. Prior to joining Globe, he was with Shell Oil Co. for 11 years doing drilling and production work in Kansas, Oklahoma, and Illinois. His future plans are indefinite.

Theodore J. Wilson, formerly in the engineering department of Kellex Corp., New York City, has joined E. I. du Pont de Nemours & Co., Inc., Wilmington, Del., as process engineer in the design division of the engineering department.

J. B. Storey has been named New Orleans district manager for United Gas Pipe Line Co., and Union Producing Co., succeeding **H. F. Carr,** who is retiring after 23 years of service. Storey joined United in 1935, and



***REUNION.**—Six oil men, members of an original group of nine geologists who worked together in Laredo, Tex., for Gulf Oil Corp., more than 25 years ago, recently staged a reunion in Houston. They are, left to right: R. A. Stehr, chief exploration geologist, Texas Seaboard Oil Co., Dallas; B. W. Allen, land agent for Honolulu Oil Co., Jackson, Miss.; H. M. Steig, geological adviser to the vice president of Phillips Petroleum Co., Bartlesville, Okla.; H. M. Nielsen, geologist, Gulf Oil Corp., Van Horn, Tex.; C. N. Housh, Houston independent oil operator; and W. F. Weed, Beaumont, Tex., independent oil operator. Three who were unable to attend the get-together are: E. O. Buck, vice president of the National Bank of Commerce in charge of the oil loan division, Houston; Carlos Lamar, chief land agent for the Mexican Gulf Oil Co., Mexico City; and Dick de Berque, radio station operator of Monterrey, Mexico.*

XUM

PERSONALS

was named district geologist in 1941 for Mississippi, Alabama, and Florida, with headquarters at Jackson. He was transferred to New Orleans in 1948 as assistant manager.

Dave Lhuillier, Cities Service Gas Co., has been transferred from Hugoton to Lawrence, Kans., as foreman to replace **Warren McDaniel,** who resigned recently to join Texas-Illinois Pipe Line Co.

J. A. Jameson, managing director of Anglo-Iranian Oil Co., London, and **T. M. W. Strong,** staff geologist for the firm, have completed a tour of Gulf Oil Corp. properties in the Permian basin. Gulf officials who accompanied Jameson and Strong on the basin trip were: **F. A. Adams,** vice president; **F. E. Hatfield,** manager of exploitation; and **Gordon H. Fisher,** manager of supply and service.

J. A. McCutchin, of Midland, Tex., will be geologist in the new offices for Bay Petroleum Corp. opened in Abilene, Tex.

Harry U. Wakefield, industrial engineer for Tennessee Gas Transmission Co., has been transferred from Houston to Boston.

Harold D. Herndon, president of Saltmount Oil Co., Denver, has resigned, effective December 31, to become a consultant in investments and royalties, with offices in San Antonio. He has been with Saltmount for 13 years and has directed the firm's royalty investments in the Rocky Mountain states and over the Mid-Continent for the past several years.

James K. Eagan, Jr., has been named general counsel of both American Oil Co., and Mexican Petroleum Co. of Georgia, with headquarters in Baltimore.

R. R. Eckart, Jr., Shell Oil Co., has been transferred from New Orleans to Donaldsville, La., as division production geologist. Other changes include: **E. B. Parmelee,** subsurface geologist at Shreveport, named district geologist; **H. F. Alberty,** subsurface geologist at Houston, transferred to Baton Rouge, in the same capacity; **J. R. Branch,** junior geologist at the Houston regional office, transferred to Shreveport as subsurface geologist; **A. J. Speegle,** junior mechanical engineer at Houston, transferred to New Orleans as mechanical engineer; **E. W. Steffenhagen,** exploitation engineer at Franklin, La., transferred to New Orleans as geologist; and **M. M. Warner,** junior geologist at Houston, transferred to Shreveport as subsurface geologist.

Adam V. Wynn has been named machinist foreman at Esso Standard Oil Co.'s Baltimore refinery.

James Eppler, geologist, has resigned from Pan-American Production Co., and joined Basil Zavoico, Houston consulting geologist and petroleum engineer.

J. B. Jones, Halliburton Oil Well Cementing Co., San Antonio, has been elected chairman of the newly organized Southwest Texas Chapter of the American Petroleum Institute. Other new officers include: **E. J. Klaeger,** Murchison & Co., vice chairman; and **R. K. Guthrie,** Seeligson Engineering Co., secretary-treasurer.

Charles S. Patterson, seismologist at Mertzon, Tex., for Stanolind Oil & Gas Co., has been transferred to Midland, Tex., as geophysical scout.

DEATHS

W. T. Holliday, 66, chairman of the board of directors of Standard Oil Co. (Ohio), died November 7 in Cleveland. He received has A.B. degree from Cornell in 1905, and graduated from Harvard Law School in 1908. Within a brief time he formed his own law firm of Holliday, Grossman & McAfee. He became general counsel for Standard in 1917. In 1928 he was elected president of the company, and held this position until 1949 when he became chairman of the board. A few of his present activities included: director of both the American Petroleum Institute and the National Petroleum Association, and member of the National Petroleum Council.

Charles C. Stanley, 72, general counsel for the western division of The Texas Co., died recently in San Marino, Calif. He joined The Texas Co. in 1927.

Cary P. Butcher, 52, Midland, Tex., independent consulting geologist, died November 4 near Durango, Colo. He was formerly with Tide Water Associated Oil Co. and Richfield Oil Corp.

Don T. Andrus, 61, well-known independent producer of Bradford, Pa., died November 8 in Bradford. He was a director and vice president of the Independent Petroleum Association of America, a past vice chairman of the Interstate Oil Compact Commission, and a past president of the Pennsylvania Grade Crude Oil Association. His producing interests were in Bradford and Allegheny, N. Y., and in Kansas and Texas. He also was a director and vice president of Kendall Refining Co.

Earle Miller, 64, independent oil operator, died November 13 in Tulsa. He had formerly been a partner in Crest Oil Co. which operated in Tulsa several years ago.

John W. Kelly, 54, chief special investigator for Texas Mid-Continent Oil and Gas Association, died November 8 in Dallas.

Harry J. Gibbons, 38, chief production engineer for Skelly Oil Co., died November 7 in Tulsa. He had been with Skelly since 1938 and was a graduate of University of Oklahoma.

William A. Sherman, president of the South Texas Oil Co., died November 8 at Houston.

Ernest V. Moncrieff, 60, former president of Swan-Finch Oil Corp., New York, died November 5 in Port Chester, N. Y. Moncrieff served as president of the company from 1930 to 1938 and was a past president of the National Lubricating Grease Institute.

Theodore G. Quintal, 39, a member of the legal staff of Socony-Vacuum Oil Co., Inc., in New York, died November 9 in that city.

Temple W. Tutwiler, 71, a director of Cities Service Co. since 1930 and a member of its executive committee and its chief engineer, died November 9 at his home in Birmingham, Ala. Tutwiler became an executive of Cities Service in 1936 and during the war was assigned the task of expediting construction of the company's new refinery at Lake Charles, La. For his record in getting the plant built and in production, Tutwiler was honored by having it named after him. At the time of his death, Tutwiler was an officer and director of a number of companies, including Empire Gas & Fuel Co. (Del.), Cities Service Oil Co. (Pa.), Cities Service Refining Corp., Arkansas Pipeline Corp., Arkansas Natural Gas Corp., Arkansas Louisiana Gas Co., Arkansas Fuel Oil Co., Dominion Natural Gas Co., Penn-York Natural Gas Corp., Surface Combustion Corp., Cities Service Oil Co. (France), Petroleum Advisers, Inc., and Orange State Oil Co.

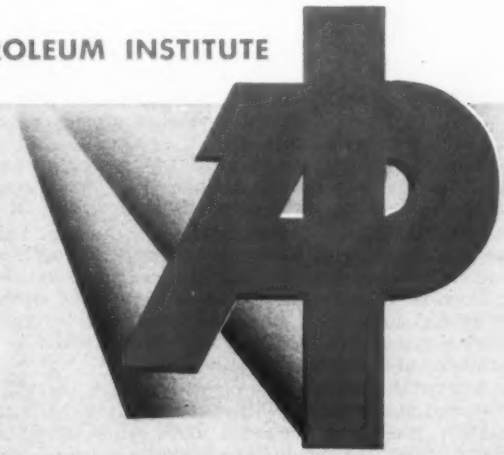
XUM

THE OIL AND GAS JOURNAL

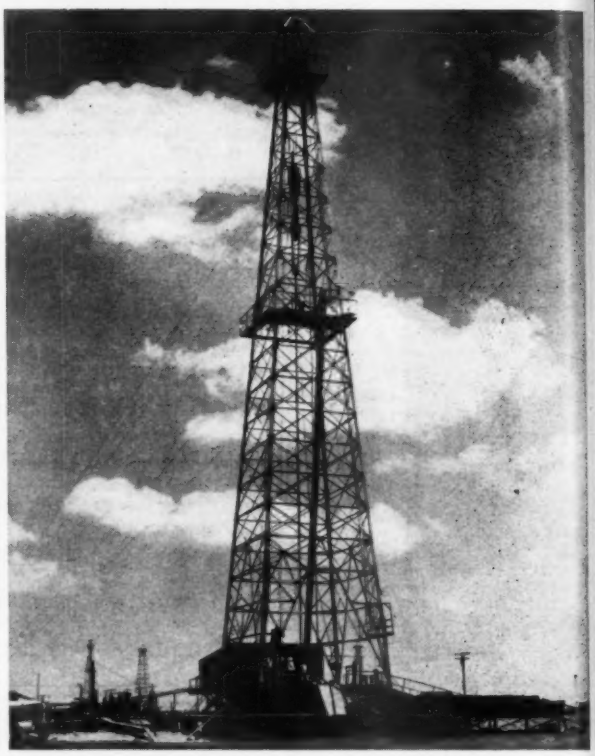
This annual A.P.I. report emphasizes the outstanding characteristic of all American oil and gas operations . . . namely, that this business of ours is a dynamic, progressive industry. Its record of growth, expansion of technology, and increases in services to the consuming public are unparalleled. The facts given on every page of the following section prove: *Petroleum Is Progress.*

30th Annual Meeting of

AMERICAN PETROLEUM INSTITUTE



ONLY THREE GENERATIONS measure the time difference between this drilling rig and . . .



TODAY'S EQUIPMENT. Rigs such as this one are capable of drilling to depths of more than 3 miles.

Petroleum Is Progress

DRILLING.—The Drake well at Titusville, Pa., in 1859 was the nation's first commercial oil well—and the real beginning of the petroleum industry. The 35-ft. wooden, ramshackle structure housed a 6-hp. engine and a clanking boiler. The first well penetrated only 69½ ft.

Modern rigs average about 120 ft. in height, some go as high as 220 ft. Some cost as much as a million dollars each. Today's wells average 3,500 ft. in depth, but men sometimes drill down 12,000 or 15,000 ft. in search for oil.

PRODUCTION.—The early days of oil were hurly-burly, pell-mell periods frequently tinged with a "boom or bust" atmosphere. In many places, wells were jammed so close together that the derricks often looked like a forest.

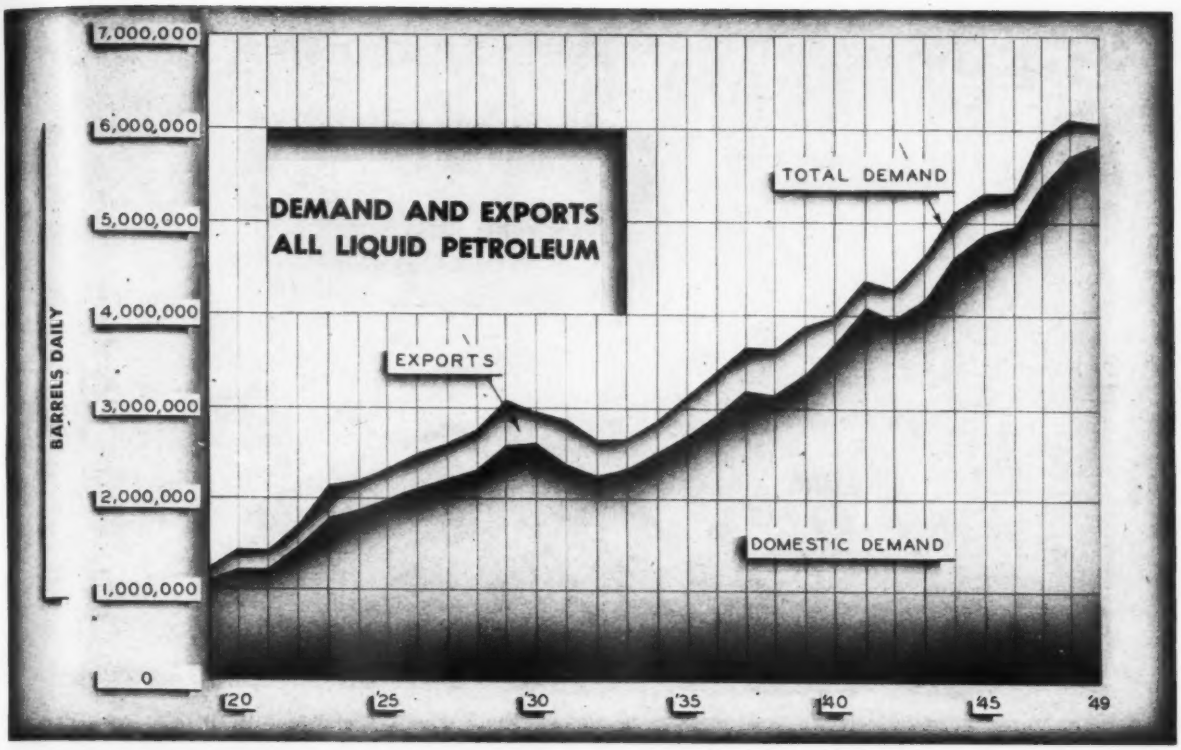
Now, wells are spaced so as to control the underground movement of reservoir fluids, and to prevent excessive withdrawal in any particular location. Maximum efficient production rates are set. Gas or water is forced back into the ground to maintain underground pressure.

REFINING.—America's pioneer refiner was Samuel M. Kier, who discovered crude petroleum mixed with the brine from his father's salt wells in Pennsylvania in 1847. Kier first marketed plain crude oil as a medicine in half-pint bottles, later distilled the oil, in 1850 building a crude 1-bbl. still.

Today, oil is processed in giant, multimillion-dollar refineries. Utilizing skills and experience developed over the 91-year history of America's oil industry, refiners extract hundreds of products and raw materials for hundreds more.

TRANSPORTATION.—In the so-called "good old days," creaking wagons and plodding horses moved bulk supplies of petroleum and other commodities. Such tank wagons were popular in the early 1900's.

Today, we have the result of long-time, comprehensive planning and construction for the transportation of petroleum and its products from the well and the refinery to the place of consumption. The system which carries out this tremendous task is made up of more than 156,200 miles of pipe lines, 447 tankers, 2,145 barges, 108,000 railroad tank cars, and more than 250,000 motor vehicles, including 147,000 tank trucks and tank trailers.



CONTINUOUS EXPANSION.—These curves show the six-fold growth of the petroleum industry in the past 30 years, from approximately 1 million barrels per day, up to 6 million.

-Its Industry Is Dynamic!

Over 200 Million Acres Leased

LANDS leased for oil and gas exploration and development in the United States comprise about 206,567,000 acres, or 322,800 sq. miles. This equals approximately the combined areas of Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Delaware, Maryland, Pennsylvania, Virginia, West Virginia, and most of Indiana.

The leases represent 10.6 per cent of the 3,022,387-sq.-mile total land and inland water areas of the United States.

Farmers and other lease holders harvest a "cash crop" of more than 1 billion dollars a year from the oil and gas industry. This is paid to them in lease rentals, lease bonuses, and royalties from the production of oil and gas.

New-field wildcats in 1949 numbered 4,449. Eleven per cent of these were successful, a percentage about the same as the 6-year average for 1944-1949.

Total exploratory wells drilled in 1949 were a record-breaking 9,058, an increase of 13 per cent over the number drilled the previous year. In 1938, the first year the records were kept, 2,638 exploratory holes were drilled, with 369 or 14 per cent successful.

With improvised technology, the percentage of successful exploratory wells in 1949 had grown to 20.2 per per cent. The average for the 1938-1949 period was 18.1 per cent. Thus, only one out of every five exploratory wells drilled produces oil or gas.

Drilling—1,298,965 Wells Total

Of the 1,298,965 wells drilled in the United States up to the end of 1949, 882,970 were oil wells, 90,831 gas wells, 300,281 dry holes, and 24,883 service wells. The latter were drilled for the injection of water or gas to increase the underground pressure which forces oil toward the producing wells.

More than half the United States oil wells are still producing although some are more than 50 years old.

An estimated 39,038 wells, including exploratory wells, were drilled in 1949, some 778 wells fewer than in 1948 when the all-time record was set. The breakdown for 1949 shows: total oil wells, 22,042; gas wells, 2,887; dry holes, 12,727; and service wells, 1,382. Total footage drilled was the greatest in history—138 million feet or more than three times the earth's diameter.

Of all wells drilled in the United States since 1859, 23 per cent have been dry. In exploratory drilling only one well in five is a producer. This demonstrates the operator's large financial risk in finding oil and gas. In proven areas, experience shows about three wells in four to be producers.

Drilling Costs

The **average** cost of drilling a well runs from $40,000 to $50,000. Many wells involve an outlay exceeding $100,000 and some cost more than a million dollars. Costs of drilling exploratory wells vary tremendously. Since four out of every five such wells are dry holes, the cost of finding a producer in an unexplored area may exceed $250,000.

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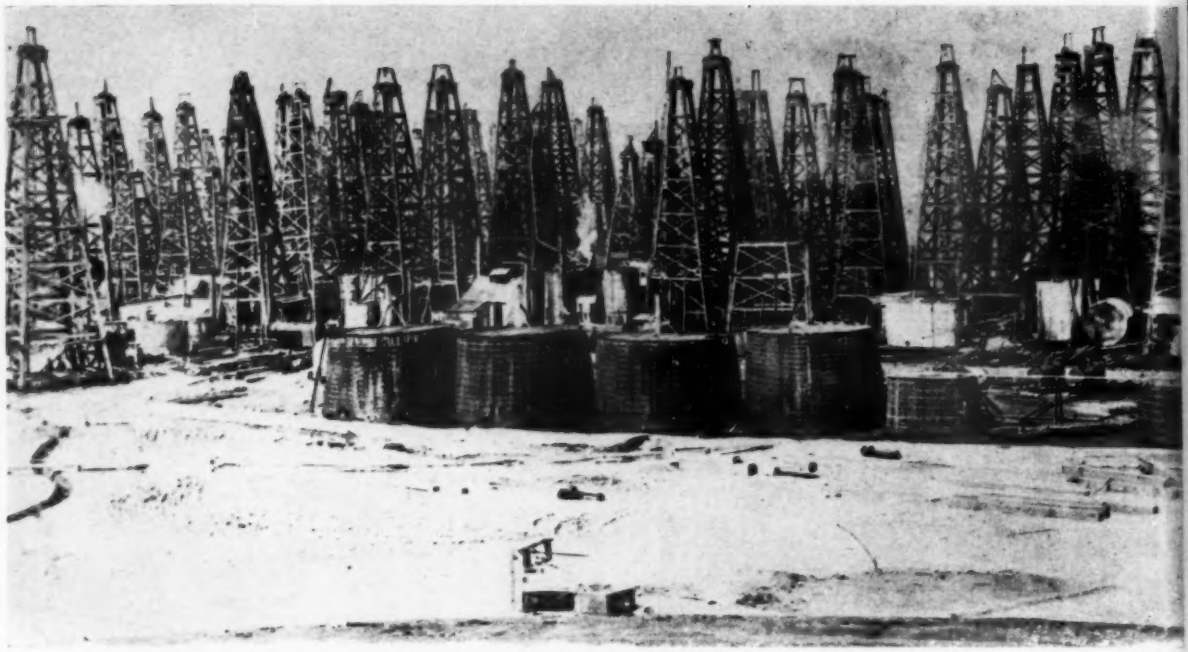


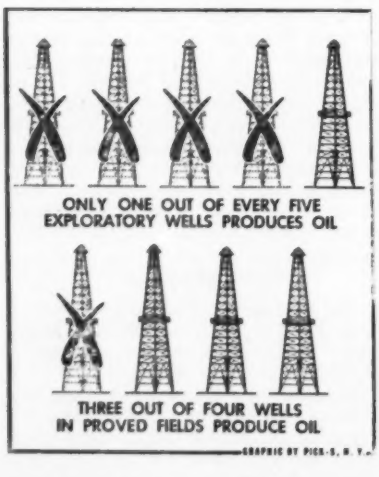
PRODUCTION PRACTICES of less than two generations ago were based on obtaining the most oil the quickest way but...

Nation's Cumulative Production Nearly 39 Billion Barrels

Studies of discovery wells drilled in the United States show that independent oil operators drill about 60 per cent of the wells that open new oil fields.

The oil industry is winning, 2 to 1, in the race to replace exhausted wells with new producers. The pace is so swift that a new producing oil well is brought in every 23 minutes. Older wells stop producing at the rate of one every 46 minutes.

Oil men in 1949 drilled an average of one well every 14 minutes, although many of these turned out to be dry.


ONLY ONE OUT OF EVERY FIVE EXPLORATORY WELLS PRODUCES OIL
THREE OUT OF FOUR WELLS IN PROVED FIELDS PRODUCE OIL
GRAPHIC BY PIDS-S. N. Y.

AMERICA has produced almost 39 billion barrels of crude oil since 1859, when our first commercial well was drilled. That is almost two-thirds of the world's cumulative production. Last year alone, the United States produced 1,840,000,000 bbl. of crude oil and condensate. This was about 54 per cent of the world's total production.

At the beginning of 1950, the United States had a total of about 449,500 producing oil wells scattered through 26 states. Totals for leading states were: Texas 116,000; Pennsylvania 83,700; Oklahoma 54,000; Illinois 31,000; Kansas 29,000; and California 24,500.

There also are about 65,000 producing natural-gas wells. Many oil wells produce both crude oil and natural gas. More than a third of natural-gas production came from oil wells in the 1945-1948 period.

At the beginning of 1948, the nation had 294,672 marginal or "stripper" wells, which averaged 2.6 bbl. a day in 1947. These wells constituted 69 per cent of the country's total producing units. They yielded 15 per cent of all United States oil production that year. Productive stripper well fields in the United States totaled 2,651,409 acres at the beginning of 1948.

Oil or gas is produced in 27 states. While there are 26 oil-producing states, and 26 gas-producing states, not all, in each category, produce both materials. For example, Tennessee, one of the oil-producing states, has no commercial production of natural gas. On the other hand Maryland has natural gas production only.

World production of crude oil in 1949 was estimated at 3,407,900,000 bbl. Of this the United States produced 54 per cent, or 1,840,307,000 bbl. This compared with estimated production in other countries, in millions of barrels as follows: Venezuela 482; Russia 255; Iran 204; Saudi Arabia 174; Kuwait 90; and Mexico 61.

Domestic production of crude oil, natural gasoline, and condensate amounted to an average of 5,470,000 bbl. a day during 1949 as compared with 5,922,000 bbl. a day in 1948 and 4,073,000 bbl. daily in 1941.

Conservation Methods Greatly Improved

Oil research, engineering, geology, and geophysics have made vast strides in the past 30 years, not only in the finding and refining of oil, but also in the recovery of oil already found. A few decades ago, as little as 20 per cent of the oil in a new field

PETROLEUM IS PROGRESS

MODERN PRACTICE calls for producing more oil by regulated withdrawals through fewer wells.

was thought to be recoverable through the use of then existing methods. This percentage of expected recovery has been greatly increased by improved production practices and many supposedly depleted fields have been restored to economic production by secondary-recovery methods.

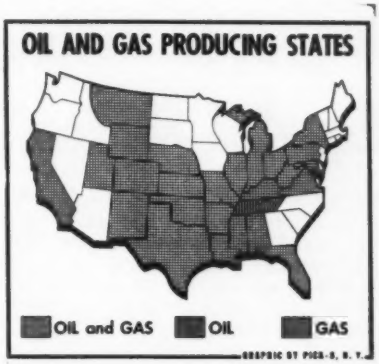
Gushers are gone.—Gushers, which used to run wild and flood the surrounding country with oil, are practically things of the past. By studying petroleum reservoirs and developing equipment to harness nature's subterranean gas pressure, producers now control the production from the moment the well is completed. Only a mishap could cause a gusher now.

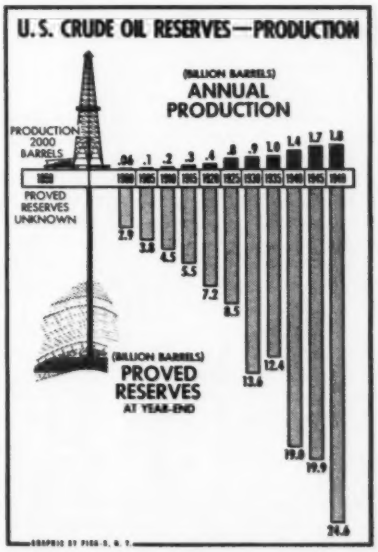
Proration firmly established. — In earlier years, under the "law of capture," oil belonged to the man who could find and produce it. The fact that it might have migrated from beneath his neighbor's land was of no concern to the producer. Increased knowledge of the structure and behavior of subterranean reservoirs resulted in the adoption by the petroleum industry of improved production practices. Greatly increased total recovery of petroleum resulted. In 1915, Oklahoma adopted a statute prorating the production of oil among fields, or wells, to prevent waste. Other states adopted similar measures. Eventually, conservation laws embraced the spacing, drilling, casing, completion, and operation of oil and gas wells. These laws promote conservation and the maximum ultimate recovery from underground reservoirs.

Oil reserves.—Proved reserves represent the amount of oil, natural-gas liquids, or gas estimated as recoverable by the production system in operation at a given time. They include only those reserves of which the location and extent have been proved and measured by drilling. Through the continued discovery of new oil reserves the industry has kept ahead of the increasing use of petroleum products. During 1949, in addition to production of nearly 2 billion barrels of oil, 1.5 billion barrels was added to proved reserves of liquid hydrocarbons.

Since the early days of the industry, known oil reserves have increased almost constantly, despite ever-increasing production and consumption. In 1925, proved crude-oil reserves were estimated to be 8.5 billion barrels. Crude production since that time has totaled 30.2 billion barrels, more than three times the estimated 1925 reserves. Yet, today's proved reserves of crude oil alone stand at the all-time high of 24.6 billion barrels or nearly three times the estimate for 1925.

Gas.—Proved reserves of natural gas in the United States at the first of this year were estimated at 180 trillion cubic feet, in increase of 6.5 trillion feet, or 3.4 per cent, over the underground supply a year earlier. Since 1925, when reserves approximated 23 trillion cubic feet, the proved supply of natural gas has increased eightfold.





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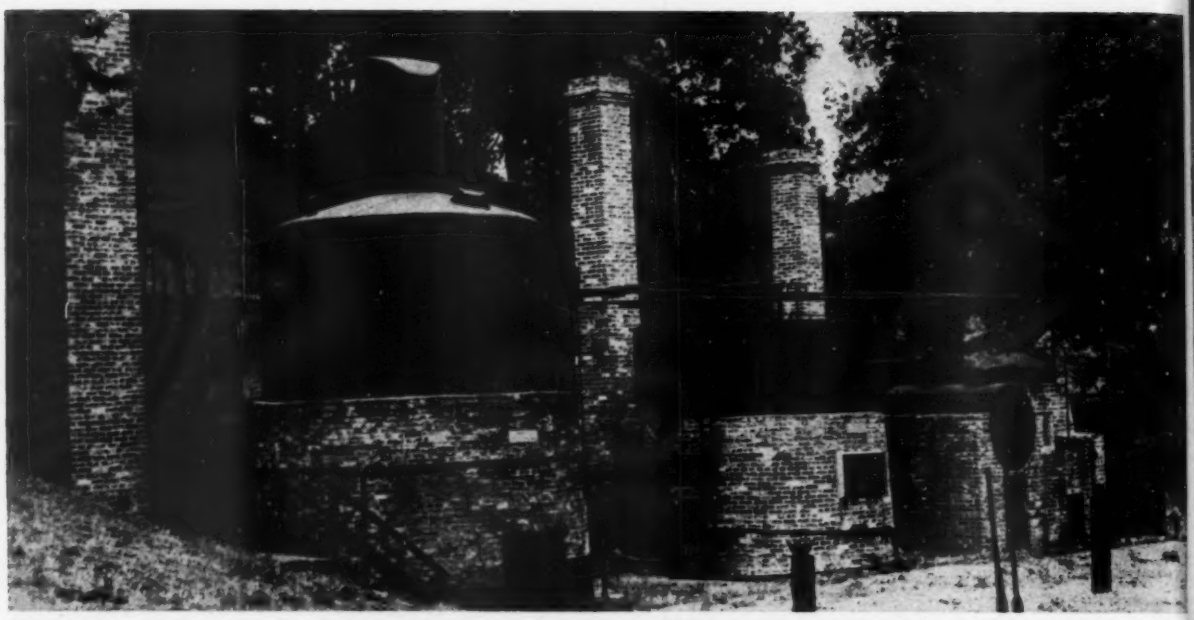


EARLY-DAY REFINERIES such as this one operated principally to obtain kerosine and lubricating oil. Disposal of gasoline was a major problem, usually solved by dumping it into creeks and rivers.

Improved Refining, Better Engines Equal 2 Million Barrels Daily

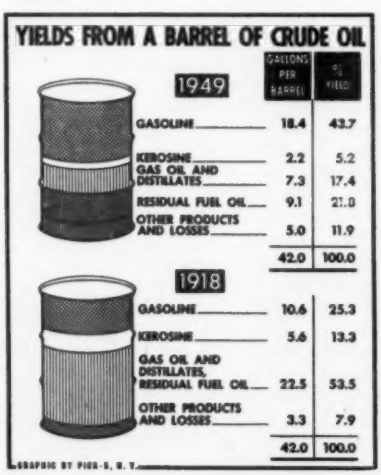
MAJOR products made from crude oil are gasoline, kerosine, light and heavy fuel, and lubricating oils. The average 42-gal. barrel of crude in 1949 produced 18.4 gal. of gasoline, 2.2 gal. of kerosine, 7.3 gal. of light fuel oil, 9.1 gal. of heavy fuel oil, and 1.0 gal. of lubricating oil. The remaining 4 gal. included coke, asphalt, waxes, and other products. Losses were nominal; .6 per cent.

Gasoline Yield and Quality

The percentage yield of gasoline from crude oil has almost doubled since 1918. In that year, 25.3 per cent of the yield from the average barrel of crude oil was gasoline. As a result of improved refining techniques, the yield in 1949 averaged 43.7 per cent. Annual total motor-fuel production multiplied 11.3 times in the same period, although production of crude oil multiplied only 5.2 times.

If methods of gasoline manufacture used in 1910 were employed today, gasoline production from the total amount of crude oil extracted from the ground in the United States in 1949 would have fallen short of meeting our needs by about 27 billion gallons. Moreover, even the meager quantity produced would not have worked satisfactorily in present-day cars. The thermal and catalytic cracking processes developed by the oil industry not only produce more gasoline per barrel of crude oil, but yield products far superior to those obtained by the original straight distillation process.

Expressed in terms of antiknock quality, regular-grade gasoline in 1949 had an average octane number (motor method) of 76 compared to 60 in 1930. Premium gasoline had a rating of about 80, compared to 70 in 1930.



The combination of improved engine design and better fuel quality has given the traveling public a 54 per cent improvement in fuel economy, expressed in terms of ton-miles traveled per gallon of gasoline. This has meant a saving of hundreds of millions of dollars a year since 1930.

Without these two factors—extra yields of better gasoline, and improved automobile engines—crude-oil production would have to be boosted by more than 2,000,000 bbl. a day to meet our needs. That would be equivalent to 83 per cent of the current daily production of Texas.

Lubes.—The volume of demand for automotive lubricating oils increased from a little over 5 million barrels in 1920 to about 22 million barrels in 1949. Industrial lubricating oil volume advanced from some 10 million barrels to about 17 million barrels during the same period.

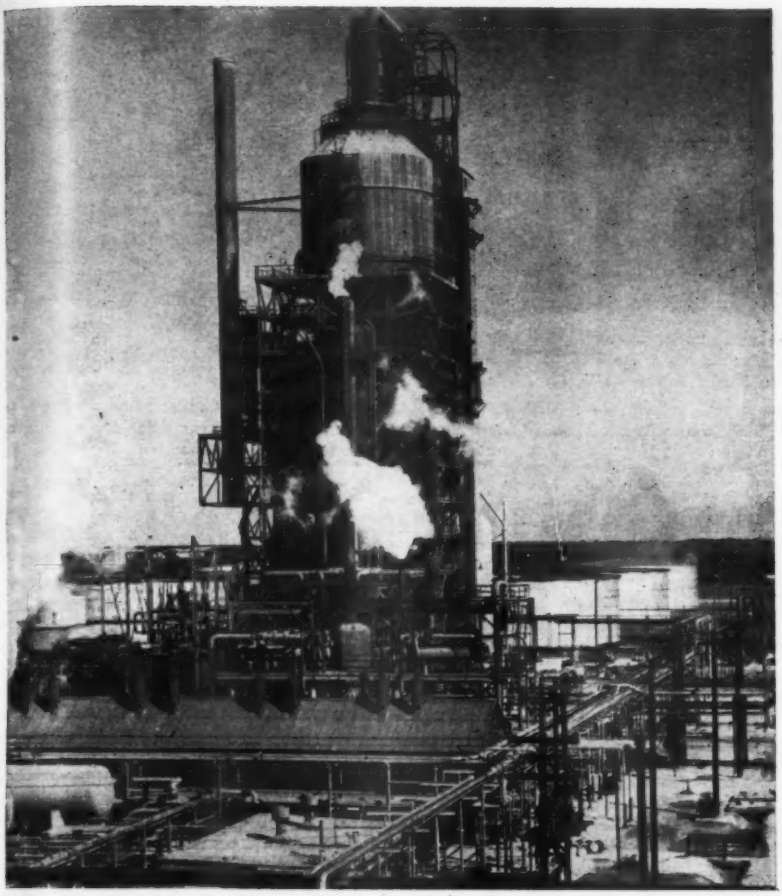
Research in Refining

The refiner displays an intense eagerness to reduce costs through the application of research, invention, and engineering ingenuity. There are few industries where operating efficiency and the development of new and better products are pursued so relentlessly.

Refinery equipment often becomes obsolete within a few years, sometimes long before it really wears out.

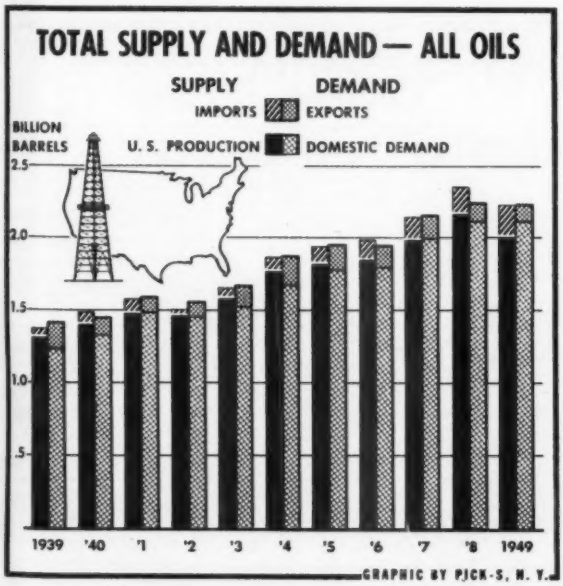
Supply and Demand

Indicated total demand during 1949 averaged 6,119,700 bbl. daily. This represents a nominal decline of 23,300 bbl. daily from 1948, when the total



IN TODAY'S REFINERY, stepped-up gasoline production is the number one problem. High-quality gasoline is produced at the rate of millions of gallons daily by this and other cat crackers throughout the nation.

Petroleum Pays Higher Wages



demand was the greatest in history. In 1941, however, it was only necessary for the industry to supply 4,369,000 bbl. daily to meet total demand.

The decline in exports was the prime factor in the decrease in total 1949 demand from 1948. Exports decreased from 134,674,000 bbl. to 119,475,000 or 11 per cent. The items showing a decrease were kerosine, distillate fuel oils, residual fuel oils, coke, and asphalt. Exports of lubricants decreased moderately. Exports of motor fuel, wax, and miscellaneous products showed an increase.

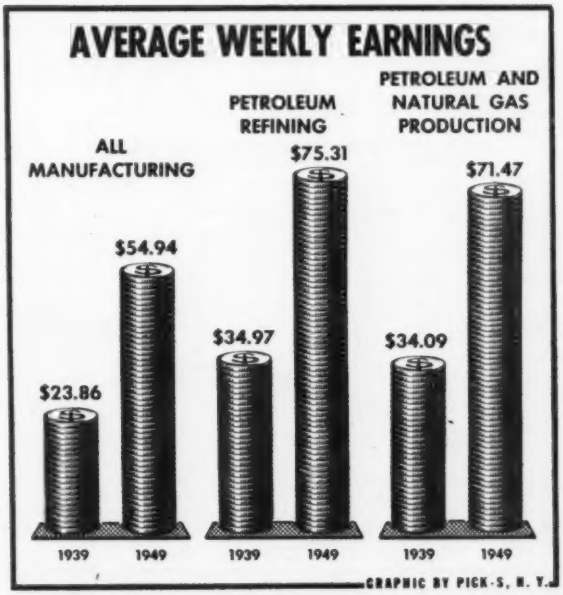
In 1939, exports accounted for 13 per cent of total demand; in 1949 for only 5 per cent. Most were refined products. In 1949, gasoline and other refined products accounted for 72 per cent of all oil exports. In 1939, however, refined products accounted for 62 per cent. Crude oil made up the remainder.

Although total demand declined slightly in 1949, domestic demand was the greatest in history, averaging almost 5,800,000 bbl. a day. This was 19 per cent greater than demand during the wartime year of 1945, when military requirements were at record levels; and 42 per cent over the 4,070,600 bbl. daily of 1941.

Chemicals. — Only 25 years ago, chemicals made from petroleum and its byproducts totaled only about 75 tons annually. The major portion of organic chemicals then came from coal tar, wood, and fermentation processes. Today, the petrochemical industry produces each year about 2½ million tons of raw materials for synthetic organic chemicals.

Wages Above Other Industries

The oil industry has always paid higher wages than industry in gene-



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WITHIN THIS FIRST HALF of the century transportation of refined products has moved from this small-capacity tank wagon to...

HIGHWAY TRANSPORTS. Huge tank trucks today distribute refined products within an area thousands of times larger than its horse-drawn predecessor.

ral. According to the Bureau of Labor Statistics, average weekly earnings for petroleum refinery workers during 1949 amounted to $75.33, or 115 per cent above the $34.97 average of 1939. Earnings for all manufacturing industries, during 1949 averaged $54.94, compared to the 1939 level of $23.86.

Last year the oil business provided steadier employment than the average American industry. During 1949, for example, the separation rate (the number of workers out of every hundred who quit or were discharged for any reason whatsoever) for all manufacturing concerns was 4.2, compared with 1.0 for petroleum refining.

Production Pay Also Up

Average weekly earnings for the worker in the crude-petroleum and natural-gas-production branches of the oil industry were $71.47 in 1949, 110 per cent above 1939.

Per Capita Consumption in U. S. 25 Times Rest of World

PETROLEUM and natural gas in 1949, combined, provided more than half the total United States energy supply. Petroleum accounted for 36.4 per cent of this supply; natural gas for 19.4 per cent, making a total of 55.8. Coal contributed 39.3 per cent and water power 4.9 per cent.

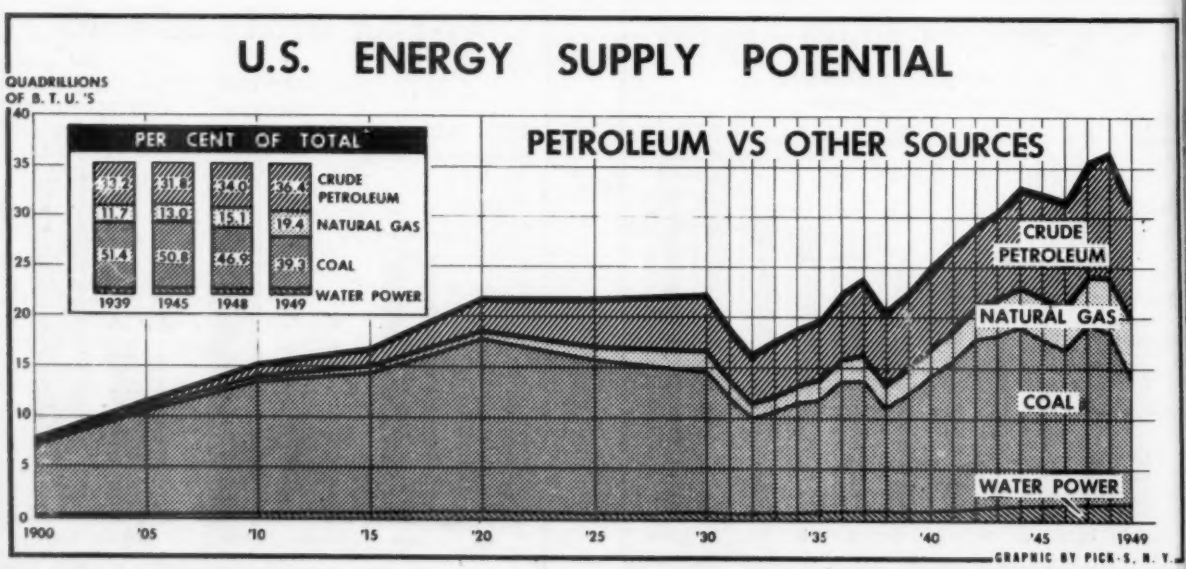
In 1915 the percentages were: coal 81.9, petroleum 10.2, natural gas 4, and water 3.9.

In absolute terms, the amount of energy derived from coal over the 1915-1949 period declined only moderately. It was about 14,000 trillion B.t.u. in 1915 and 12,000 trillion B.t.u. in 1949. During the same period, however, energy derived from petroleum increased from about 1,700 trillion to 11,600 trillion B.t.u. Corresponding figures for natural gas were 676 trillion and 6,200 trillion B.t.u.

In other words, while total energy consumption in the United States almost doubled, energy from petroleum increased seven-fold, and from natural gas nine-fold, while the energy obtained from coal remained substantially constant.

Volume of major petroleum products climbed spectacularly; from about 45 million barrels in 1900 to 1,943 million barrels in 1949, a 40-fold increase.

The per capita consumption of oil



GASOLINE STATIONS of a few decades past were sparsely located. Among the few items then sold to the motorist was filtered gasoline.

TODAY'S SERVICE STATIONS provide the motorist with high-octane fuel and premium lubricants, plus tires themselves synthetically derived from petroleum.

Huge Growth in L-P Gases

products in the United States is approximately 25 times that of the rest of the world. This comparison provides a reasonable yardstick to measure the standard of living enjoyed by the American people.

The 1949 per capita consumption of oil products in the United States was 597 gal. This was 27 per cent above the 469 gal. per person in 1941. This rise in per capita consumption accompanied a population increase of 12 per cent.

Gasoline Is No. 1 Product

Sometime around 1907, service stations appeared in different sections of the country. This method of merchandising spread rapidly. By 1920, there were about 15,000 stations; in 1948 there were 188,305. In addition, garages, repair shops, and country general stores provided another 205,000 retail outlets.

Service-station business amounted to about $6,363,000,000 in 1949. Consumer expenditures for gasoline, motor oils, and greases alone exceeded $4,500,000,000.

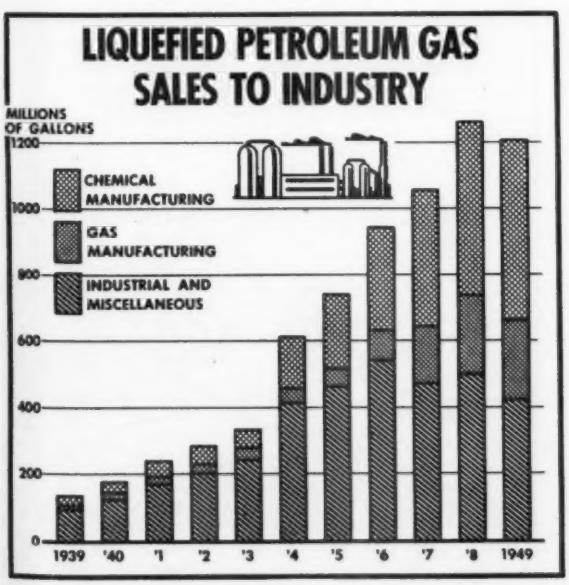
Automobiles alone account for more than 70 per cent of all highway gasoline consumption. The rest is used by buses, trucks, and motorcycles. At the end of 1949, United States automobile registrations were estimated at 35,627,989, an increase of 20 per cent over 1941. On the average, each auto in 1948 consumed 640 gal. of gasoline and traveled 9,566 miles.

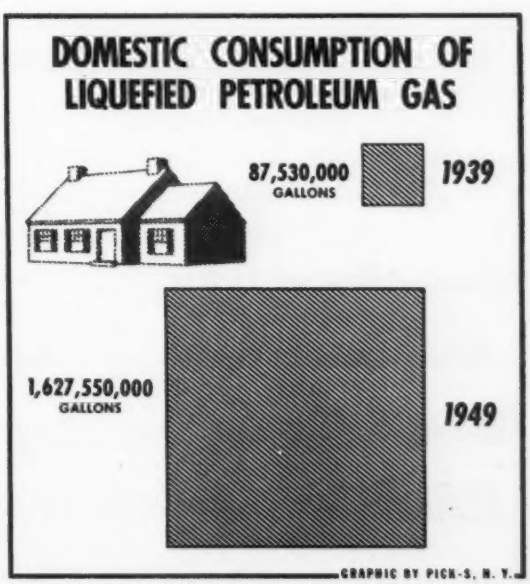
Natural Gas Versatile

Supplies of natural gas, another petrochemical raw material, are even more bountiful. In 1940, the marketed production was 2.7 trillion cubic feet, and reserves 85 trillions. Last year production was 6.2 trillions and reserves 180 trillions. Natural gas is an important source of carbon black, which is used mainly in tires made either from synthetic or natural rubber. Consumption has soared 137 per cent since 1940, to more than 1 billion pounds annually. Negligible a decade ago, production of synthetic ammonia from natural gas now is at an annual rate of 620,000 tons. Much of this production in turn enters the manufacture of nitrogen fertilizers derived from petroleum.

L.P. Gas Growth

Of total 1949 sales of 2.837 million gallons of liquefied petroleum gas (L.P. gas) 57 per cent, or 1,628 million gallons, were for domestic consumption. This was more than the amount sold for all purposes in 1945. It is used for cooking, heating, refrigera-





A.P.I. 30th ANNUAL MEETING

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tion, and power. The 6½ million homes that now use L.P. gas represent an increase of 295 per cent since 1941.

Sales of L.P. gas for industrial and miscellaneous use totaled 1,075 million gallons in 1949, or 39 per cent of the total. Chemical manufacturing took 525 million gallons, other industrial and miscellaneous uses, 310 millions gallons, and gas manufacturing 240 million gallons.

Agriculture

Farm mechanization has made striking progress in the last four decades. About 1910 the first really practical tractor was developed. Later, farm inventories of automobiles and motor trucks began a spectacular rise. Tractors caused a large-scale displacement of animal power. The 3½ million tractors on United States farms at the beginning of 1949 represents an increase of 126 per cent over 1940 and 280 per cent over 1930. Horses and mules on farms (7.5 millions at the beginning of 1950) have decreased 48 per cent since 1940.

The shift from animal to mechanical power has made it possible to divert 63 million acres of land from production of feed for horses and mules to growing food for humans.

Not only has the number of farm tractors increased tremendously since 1920 but each tractor is used 48 per cent more hours per year.

Industry's Own Facilities Half Those of All Nation's Railroads

COMPREHENSIVE planning enters into the transportation of petroleum and its products from the well and the refinery to the place of consumption. The system which carries out this tremendous task is made up of more than 156,200 miles of pipe lines, 447 tankers, 2,145 barges, 108,000 railroad tank cars, and more than 250,000 motor vehicles, including 147,000 tank trucks and tank trailers.

During postwar years, the amount of domestic petroleum transported by all these methods—pipe lines, tankers, barges, tank cars, and tank trucks—has been nearly half as great as the total volume of ton-miles handled by our entire railroad system. On the average during 1949, more than 240,000,000 gal. of petroleum products was delivered to American consumers every day of the year.

At the beginning of 1949, a network of 156,200 miles of pipe lines carried crude oil and refined products in 41 states.

Crude lines.—There were 60,020 miles of crude-oil gathering lines and about 74,440 miles of crude-oil trunk lines operating in the United States. Gathering lines are small and bring oil from individual wells to a central storage point, or directly into main trunk lines for further transportation to tank farms or refineries. Crude-oil lines of both types placed in operation during 1949 totaled 3,634 miles.

Products lines.—Refined oil or "products" pipe lines, which transport gasoline, kerosine, and light fuel oils from the refinery, have increased rapidly since 1928, when there were only 250 miles of such lines. At the beginning of 1949, there were about 21,740 miles, and 437 miles were put in operation during that year.

Oil is kept moving through the pipe lines by pumping stations. It travels at a speed of about 3 or 4 m.p.h. Diameter of the pipe ranges from 2 to 24 in. Several of the longest trunk lines extend more than a thousand miles.

Tanker Tonnage

World tanker tonnage in September 1949 amounted to 22.7 million deadweight tons. This was an increase of 74 per cent over the 13 million deadweight tons of September 1939. The United States, with 8.6 million tons (privately and Government owned), had 38 per cent of the world's tanker tonnage in 1949, as compared with 24 per cent in 1939.

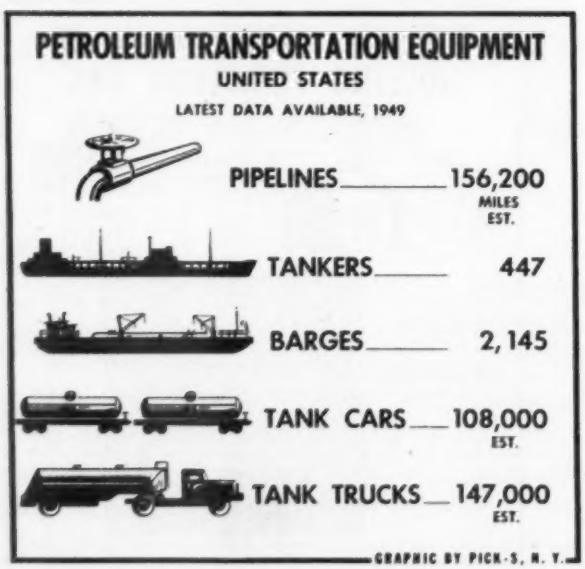
The deadweight tonnage of the United States tanker fleet in mid-1949, amounted to 19 per cent of the total United States merchant fleet, and 7 per cent of the world merchant fleet, according to the U. S. Maritime Commission.

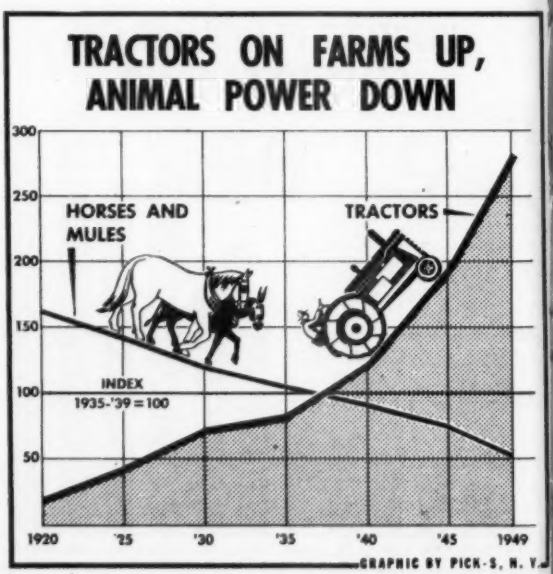
Demand Factors

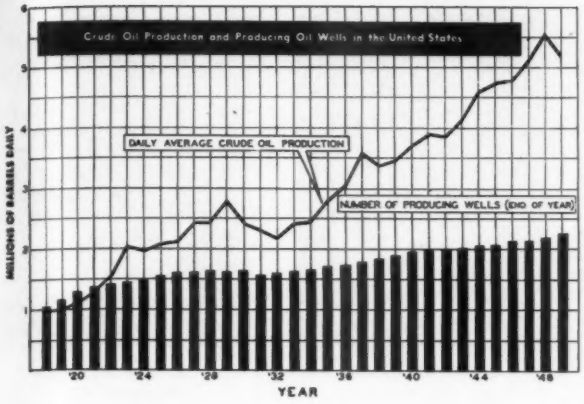
Factors causing the spectacular rise in domestic demand for oil products between 1941 and 1949 were the greatly increased use of oil-consuming equipment such as motor vehicles, agricultural machinery, oil burners and space heaters, commercial airlines, and, diesel-electric locomotives.

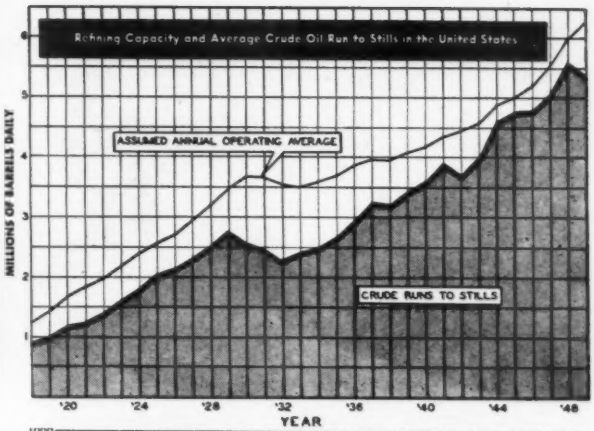
Domestic demand for motor fuel continued to rise in 1949, averaging 2,501,300 bbl. a day. This was 5 per cent more than 1948 and 37 per cent more than 1941, the prewar peak year.

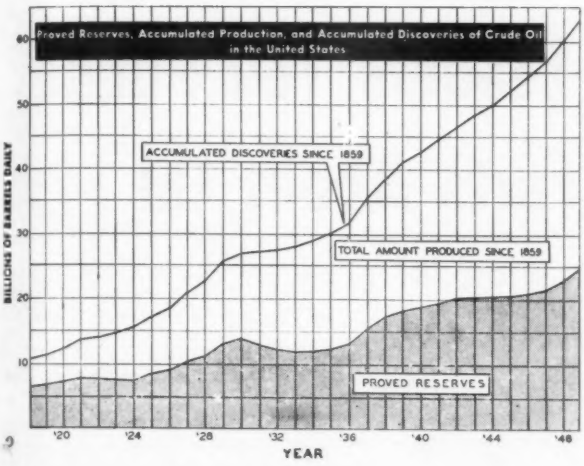
Domestic demand for major oil products other than gasoline showed a slight decrease in 1949 from 1948,

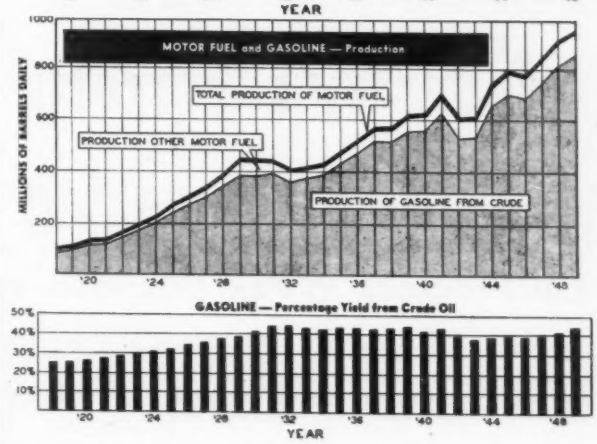





Crude Oil Production and Producing Oil Wells in the United States
DAILY AVERAGE CRUDE OIL PRODUCTION
NUMBER OF PRODUCING WELLS (END OF YEAR)
MILLIONS OF BARRELS DAILY
YEAR


Refining Capacity and Average Crude Oil Run to Stills in the United States
ASSUMED ANNUAL OPERATING AVERAGE
CRUDE RUNS TO STILLS
MILLIONS OF BARRELS DAILY
YEAR


Proved Reserves, Accumulated Production, and Accumulated Discoveries of Crude Oil in the United States
ACCUMULATED DISCOVERIES SINCE 1859
TOTAL AMOUNT PRODUCED SINCE 1859
PROVED RESERVES
BILLIONS OF BARRELS DAILY
YEAR


MOTOR FUEL and GASOLINE — Production
TOTAL PRODUCTION OF MOTOR FUEL
PRODUCTION OTHER MOTOR FUEL
PRODUCTION OF GASOLINE FROM CRUDE
MILLIONS OF BARRELS DAILY
GASOLINE — Percentage Yield from Crude Oil
YEAR

1,800,000 Workers Are Employed In All Industry's Branches

but was still far greater than prewar. Demand for kerosine last year averaged 281,300 bbl. a day. Although 8 per cent below 1948, this was 48 per cent over 1941. Gas-oil and distillate fuel oil which include the lighter types used for oil burners, space heaters, diesel-electric locomotives, diesel trucks, buses, vessels, and stationary engines, averaged 898,700 bbl. a day during 1949. They declined 3 per cent from 1948, but were 90 per cent higher than 1941. Residual fuel oil, the heavy grade used by ships and in industry averaged 1,357,000 bbl. per day in 1949. This was a decrease of 1 per cent from the previous year, but an increase of 29 per cent above 1941.

Military Needs

Military petroleum requirements are an important factor in total demand. For the fiscal year ending June 30, 1950, these requirements were estimated at 101,887,000 bbl. While considerably below the 1945 requirements, these were still more than eight times the 1941 needs of 12 million barrels.

Winter Demand Up

In recent years the seasonal consumption of oil has shifted. Prior to the mid-1930's, gasoline dominated the petroleum market. Then months from April to September saw the heaviest consumption. In the meantime, the use of fuel oils in the home, in industry, and in diesel trucks and tractors and diesel-electric locomotives, grew tremendously. As a result, oil consumption from October through March now exceeds summer demand.

About 1,800,000 workers are currently employed in the oil business. Of these more than 200,000 work in the various production activities: exploration, drilling and rig building, and operating and maintaining the nation's producing wells. Another 250,000 are employed in the refining branch, while 225,000 workers are engaged in transportation. In addition, there are administrative and clerical personnel and at least 700,000 at the retail level.

Thirty years ago the oil industry employed 200 technologists. Today U. S. oil companies employ about 15,000 people in research activities. The industry spends about $100 million a year in research to improve its products, services, and equipment. That is about one-fourth of the sum spent by all industry on research.

Investment About Twelve Billion

The petroleum industry represents a net investment of about $12 billion. Its investment is exceeded only by those in agriculture and railroads.

A record expansion program in the oil industry followed World War II. To meet the greatly increased demand by the consuming public, more than $8 billion were expended in 1946-1949 for new and enlarged production, refining, transportation, and distribution facilities. This yearly average of more than $2 billion contrasts with the $643 million average annual investment made by oil companies during the 1934-1939 period.

XUM

ROBERT L. MINCKLER
President, General Petroleum Corp.

W. J. CARTHAUS
Vice president, Deep Rock Oil Corp.

L. F. McCOLLUM
President, Continental Oil Co.

W. ALTON JONES
President, Cities Service Co.

Industry's Forceful Leaders Tell Public Some Amazing Facts About Oil

Oil Progress Week provides occasion for series of public appearances by oil men. Here is reported some of what they said.

Hoyt Ogram, Kanotex Refining Co., —Speaking at Chicago:

"The oil industry is like a great and large complex machine made up of many parts, both large and small. Let us compare it with an automobile; take the chassis and the spark plug. There is a great difference in their sizes to be sure, but each of them quite important for the smooth operation of that automobile. The oil industry is just like that. Whether you are a small producer; a small pipe-line operator; refiner; marketer; compounder; terminal, marine or service-station operator, you are a vital and necessary unit to the smooth operation of service to the American economy."

W. Alton Jones, president, Cities Service Co., and chairman of the board, American Petroleum Institute, —Speaking at Chicago:

"In the 5 postwar years American oil companies have invested more than 10 billion dollars in the improvement of existing facilities, construction of new plants, and development of new oil sources. This was achieved not by a few companies, but by thousands of privately owned and managed oil companies, operating under the free-enterprise system which is the real source of our national strength."

. . . and recently at New York, Jones said:

"The demand for petroleum has been increasing 50 times faster than the population growth. To supply this demand has meant drilling thousands of wells every year, and it costs as much as $250,000—even as much as $1,500,000 in exceptional cases—to drill a single well, which may go 20,000 ft. deep and still not find oil. . .

"Drilling, however, is just one part of the over-all job. Oil must not only be found and produced—it must be processed, stored, transported, and delivered. . .

"The Automobile Manufacturers Association in a roundup of facts and figures for 1949, reveals that in that year there were 44,670,000 cars, trucks, and buses registered in this country—more than 36,000,000 of these passenger cars. That's one for every 3.3 persons in the nation. There isn't another nation in the world that's within shooting distance of that figure. Line up the 150,000,000 men, women, and children in the United States along a highway. Let them hitch-hike rides in America's motor vehicles, three to a car. We should run out of hitch-hikers and have a million cars left over. Literally, we are a nation on wheels. . .

". . . There are more places in the United States, in fact, 100,000 more places—where you can fill up your car tank than there are eating places where you can fill up your stomach."

C. L. Harding, director, Socony-Vacuum Oil Co., Inc.,—Speaking at Chicago:

"Through the investment of private American capital abroad, American interests have made available to themselves outside our country about 31 per cent of the total world's crude-oil reserves, in addition to the reserves within the boundaries of the United States. Our total American interest in crude-oil reserves throughout the world is roughly equivalent to 52 billion barrels. By far our greatest foreign reserves are in the Middle East. Of the approximately 33 billion barrels now proved in that area—a figure certain to be greatly increased by additional drilling—the share held by United States' companies is about 43 per cent."

Dr. Robert E. Wilson, chairman of the board, Standard Oil Co. (Ind.),—Speaking at Detroit:

" . . . We used to consider that a 25 or 30 per cent recovery was a fairly good job in the old days of wide-open production, and letting the well blow its head off. In those days we would try to get most of the oil out before our neighbor got his out, while he was trying to do the same to us, regardless of how much either of us got for it. We were lucky to get 25 or 30 per cent of the oil in the sand (the porous rock, really) before the well went dead. That was because when you produce too rapidly, you tend to pull water in from below,

T. H. BARTON
Board chairman, Lion Oil Co.

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J. C. DONNELL, II
President, Ohio Oil Co.

R. W. McDOWELL
President, Mid-Continent Petroleum Corp.

ROBERT E. WILSON
Board chairman, Standard Oil Co. (Ind.)

shutting off a lot of oil away from the hole, or you pull gas in from above and the well goes to gas, for which there might be relatively little need.

"Today we don't think we are doing a good job under proration in most fields unless we eventually recover something like 70 per cent of the oil in the sand. You may think that 70 per cent recovery isn't anything to brag about, but when you consider that the porosity of the rock we are talking about is roughly that of concrete, and the fact that we are producing the oil under 20, 30, or 40 acres of land, from a sand with a thickness of maybe 6 ft., through a single 8-in. hole, you realize that to get out 70 per cent of that oil represents a real engineering achievement."

T. H. Barton, chairman of the board, Lion Oil Co.,—Speaking at Nashville:

"Our 34,000 competitive companies employ directly some 2 million people. They work in the oil fields, in the refineries, in the offices, in the laboratories, in the 250,000 service stations, and in the 30,000 bulk distributing stations. Another 975 million people are employed by industries that are directly related and dependent on the oil industry. These workers and their families account for 34 million men, women, and children. They comprise more than 23 per cent of the total working population of the United States."

R. W. McDowell, president, Mid-Continent Petroleum Corp.,—Speaking at Des Moines:

"In the last 25 years our industry has plowed back 25 billion dollars (an average of 1 billion dollars a year) into the discovery and development of new reserves. In recent years the cost of finding and developing crude oil has averaged nearly 2 billion dollars annually, representing approximately 60 per cent of every dollar received from the production and sale of crude oil in this country.

"In the past 25 years the industry has drilled approximately 650,000 wells for a total footage in excess of 2 billion feet. That program has produced 48 billion barrels of new reserves—more than 1½ times the national consumption of 31 billion barrels, including the demands of the greatest war in history. Our American oil industry supplied almost 90 per cent of all the oil used by the United States and its allies and still was able to report the largest reserves in our history on January 1 of this year."

J. C. Donnell II, president, The Ohio Oil Co.,—Speaking at Sidney, Nebraska:

"On Friday, May 13, 1949, an event of considerable importance to the people of Cheyenne County took place a few miles to the northeast of Sidney on the farm of Mrs. Mary Egging. Despite the rather foreboding date, it was on that day that Ohio Oil Co.'s wildcat well, 1 Mary Egging, encountered saturated oil sand at a depth of 4,401 ft. and set off Cheyenne County's and western Nebraska's commercial oil development. . . . Perhaps we may assume that the rest of the industry thought we were fishing in poor waters. . . .

"As it has turned out, the fishing hasn't been too bad, and quite a few others have thrown in their lines. You are familiar, of course, with the more recent progress—the development of Gurley field; the discovery of Huntsman, McLernon, Warren, Sunol, and West Sidney fields in Cheyenne County; Big Springs field in Deuel County in Nebraska; and in Colorado the East Armstrong, Merino, and Walker fields in Logan County, Fort Morgan field in Morgan County, and Buckingham field in Weld County."

Walace Hawkins, vice president, Magnolia Petroleum Co.,—Speaking at Odessa, Texas:

"One of the most exploited misconceptions concerning the oil and gas business is that the oil industry constitutes a monopoly. Now what are the facts? Is the door to the oil and gas industry open and can new enterprises enter it in whole or in part? Can an oil man grow and prosper in the business? Those in the industry well know that it is a competitive one and that instances without number of entry, progress, and growth of new and different units are within the personal knowledge of every oil and gas man."

Walter S. Hallanan, chairman of the National Petroleum Council and president of Plymouth Oil Co.,—Speaking at Pittsburgh:

"Dictator Stalin will ponder long before launching an all-out war against the United States if for no other reason than that the overwhelming superiority of our nation in oil reserves would subject the Soviet to an insurmountable handicap. . . . The oil reserves of the United States are six times greater than those of Russia and its satellites. Our production is seven times greater, and in refining capacity, which is the big factor militarily, the United States has a seven-to-one advantage."

R. F. Baity, vice president of sales, Standard Oil Co. (Ind.),—Speaking at Chicago:

"Perhaps you would like to know what gasoline would cost you in other parts of the world. On the basis of the latest information I have available you would pay in our money for a gallon of regular-quality gasoline 37 cents in Calcutta, 41.6 cents in Manila, 28.7 cents in Capetown. You would pay 38.1 cents in Cairo, 70.3 cents in Rome, 35.7 cents in London, 50.2 cents in Paris. You would pay 49.6 cents in Berlin, although black-market gasoline there has been selling for 98 cents. In Vienna you would pay 29.3 cents in the American zone and 52.5 cents in the Russian zone. You would pay $1.60 in Madrid.

"Gasoline today really stands out

WALACE HAWKINS
Vice president, Magnolia Petroleum Co.

WALTER S. HALLANAN
President, Plymouth Oil Co.

FRANK M. PORTER
President, A.P.I.

ROBERT G. DUNLOP
President, Sun Oil Co.

as a bargain when you compare gasoline prices with prices of other commodities you buy, using almost any base period. Using the consumers' price index based on average prices in the years 1935-39, for example, the price of gasoline, less taxes, has risen only a little more than half as much as the increase in the prices of commodities in general."

T. S. Petersen, president, Standard Oil Co. of California.—Speaking at San Diego:

"At the present time, the petroleum industry is better prepared to meet any national emergency than it has ever been before. . . . Our domestic capacity to produce and refine petroleum has increased around 25 per cent since the peak demands of World War II. Our proved crude-oil reserves have been upped by approximately that much through exploration for new fields. And American oil companies in the last 5 years have plowed back into their business nearly 10 billion dollars to provide new facilities, and find and develop more crude oil."

John W. Boatwright, general manager, distribution economics department, Standard Oil Co. (Ind).—Speaking at Joliet, Ill.:

"Why is [the petroleum industry] ready to meet all conditions? The answer is competition. The management of the Standard Oil Co. is constantly alert to the aggressive competition of Texaco, Globe, Shell, Socony, Sinclair, Phillips, Martin, Johnson, Spur, and thousands of other petroleum companies. We don't dare let any one of them get the jump on us. Just as we are constantly seeking ways where we may get the jump on them, each of them is working steadily to get the advantage over each of the others. Collectively, competition is a spur to our activity. We dare not become complacent for a single minute. Our competitors in turn feel that they cannot rest on their oars or the race will be lost."

L. S. Wescoat, president, Pure Oil Co.—Speaking at Toledo:

". . . Fuels compete with each other, but in one respect petroleum is noncompetitive, and is indispensable to all other industries. I refer to lubricating oil, without which the machine age would grind to a sudden stop. The conquest of friction is one of mankind's greatest achievements. Without lubrication there could be no mass production, no great cities, no tall buildings. Building elevators, and equipment for fire fighting and pumping water and sewage would be worthless—to say nothing of all rapid-transit facilities. The petroleum industry makes hundreds of grades of lubricating oil, to work under terrific heat or the subzero temperatures of the stratosphere."

Robert G. Dunlop, president, Sun Oil Co.—Speaking at Philadelphia:

"When it comes to retail gasoline pricing, many people are confused by the fact that most dealers display the trade-marks and feature the branded products of integrated (so-called major) oil companies. These people think the products are owned and priced by the companies whose brands they bear.

"This is not correct. When you buy gasoline from a Sunoco service station, you are not, unless you happen to be in one of our very few company-operated stations, buying directly from Sun Oil Co. You are doing business with a self-employed businessman, who either leases or owns his station, risks his own money in inventories, hires his own employes, and has full responsibility for pricing his items to meet the competitive conditions of his locality."

Frank M. Porter, president of American Petroleum Institute.—Speaking at Boston:

"If all of the common-carrier railroads, trucks, airlines, barges, and other marine equipment serving the general public were suddenly called upon to take over the job of transporting and distributing our daily petroleum requirements, it would mean the displacement of over 50 per cent of the combined services of these carriers to all other shippers. It has, as a practical matter, become necessary for the petroleum industry to create its own transportation and distribution systems to meet its particular needs. I know of no other industry that has assumed such public obligation requiring the magnitude of financial investments and industrial operations as are found in the oil industry."

J. C. Richdale, assistant to president, Esso Standard Oil Co.—Speaking at New Haven, Conn.:

"One must be an optimist to drill 2 miles into the earth to find his raw material. However, the industry found the gamble could be minimized by research and that was also true in every operation from discovery of the crude to the finished product. As a matter of fact, one quarter of all the money spent for industrial research in America is spent by the petroleum industry. My own company spends 20 million dollars a year in the development of new and better products."

Robert L. Minckler, president, General Petroleum Corp.—Speaking at Salt Lake City:

". . . We in the oil business are engaged in handling and moving about a very heavy, bulky, rather low-grade commodity. We search for it in the bowels of the earth, we lift it out of the ground, put it in tanks, pump it out of the tanks and through a pipe line, perhaps several hundred miles long, to a refinery where we lift it again with temperature and pressure, put it in more tanks, clean it up, mix it up, put it on a ship or in a tank car or a truck or a pipe line, move it again perhaps hundreds of miles to a terminal of some sort, unload it, load it up again and haul

L. S. WESCOAT
President, Pure Oil Co.

T. S. PETERSEN
President, Standard Oil of California

CHARLES L. HARDING
Director, Socony-Vacuum Oil Co., Inc.

J. C. RICHDALE
Assistant to president, Esso Standard Oil Co.

it to a bulk plant, unload it, load it again, and take it to a service station, put it in a tank again, pump it out into the customer's automobile tank, wipe his windshield, give him air and water, provide him with bathroom facilities, and charge him 3 cents per pound. What other product that requires all of that human labor and energy in its handling can you buy for 3 cents a pound? Bread is about 20 cents, milk is about 15 cents, lumber is about 12 cents, an automobile about 80 cents. And that 3 cents is for gasoline, one of our very fanciest products. Fuel oil is only ¼ to ½ cent per pound, down in the range of prices of rock and gravel."

L. F. McCollum, president, Continental Oil Co.—Speaking at Tulsa:

"A speaker in Colorado once held up a $20 gold piece, and offered it to anyone in the audience who could name a person who doesn't use oil in some way. In the back of the room, a smile spread slowly over the face of one listener. He held up his hand. "A dead man," he said. The speaker answered immediately. "Dead men have to be buried," he said. "They are taken to cemeteries in hearses that require gasoline and oil." The listener answered: "This dead man was old fashioned. He requested that he be buried from a horse-drawn carriage." But petroleum still entered the picture, and the speaker kept his $20 gold piece, because the wheels on a carriage have to be lubricated with grease."

W. J. Carthaus, vice president, Deep Rock Oil Corp.—Speaking at Cushing, Okla.:

"Competition in the oil industry is as operative now as it was in the days of the first scramble for oil land leases here in Oklahoma. . . All of you here in Cushing are aware of the many millions of dollars the stockholders of Deep Rock poured into our refinery here over the last several years. This was not done, I assure you, for any other reason than to stay in business. Our competition forced it upon us but the benefits have been far reaching and worth while to thousands of people."

A. A. Stambaugh, director, Standard Oil Co. (Ohio).—In radio broadcast over 43 stations:

"Every member of our industry, big and little, with scarcely an exception, has been plowing back into plant and equipment all the money that they could borrow or earn to meet the public's needs. . .

"It is significant that the 30 largest oil companies in our country earned a total profit in the 4-year postwar period of 1946-1949 of $5,227,000,000, while during the same period they spent on new capital investment a total of $8,256,000,000, some $3,000,000,000 more than they earned. The difference had to be made up through borrowing and other sources."

M. J. Rathbone, director, Standard Oil Co. (N. J.)—Speaking at Jackson, Miss.:

"While oil is primarily a fuel and lubricant, no review of its use would be complete without mentioning the multitude of other products that have come directly from petroleum. In its early commercial days, crude oil yielded only a handful of products. Now we look upon the hydrocarbons it contains as the building blocks for many novel and useful things unknown to us before. Some of the newest are petroleum alcohols which have provided many industries, such as the paint and enamel industries, with cheaper and better solvents; detergents to replace and improve soap; plastics for a hundred uses; butyl rubber for air-tight inner tubes; weed killers to increase foodstuffs, and ammonia for fertilizers.

"We know this list is only beginning to name the useful products that will eventually come from petroleum. Most of these new products were found because the oil industry keenly recognizes the value of industrial research. Today, one quarter of all the money spent for industrial research in the United States is spent by the oil industry alone. And, of course, this great research effort has not been confined to the development of new and better products. Over the years, we have learned how to find oil more efficiently and how to obtain greatly increased recoveries from oil reservoirs. Incidentally, a good indication of the results of research in oil reservoir behavior is the saying that more oil has been found in the laboratory than in the field—a reflection of our higher recoveries which have added so greatly to our real reserves.

". . . since the end of the war the 34,000 companies that make up the oil industry have spent more than 10 billion dollars for new equipment, new plants, and new facilities to completely utilize the results of research."

W. R. Huber, retail market general manager, Gulf Oil Corp.—Speaking at Columbus, Ohio:

"The role of big business in the last war and in the present Korean situation surely should be proof of its worth and desirability. If every company was a small company, then no company in the oil industry, for example, would have had the modern facilities necessary to provide the tremendous quantities of high octane gasoline required by our air forces. Neither would they have been able to provide the millions of gallons of products vital to keeping our ground forces and our Navy on the move, to keeping our plants turning out tanks, ships, guns, planes, and other needed materials.

"If businesses could not develop beyond a specified point, initiative would be stifled. Much of the research which has contributed so greatly to this age of miracles in which we live would never have been accomplished, and as a country we would be in a period of retrogression."

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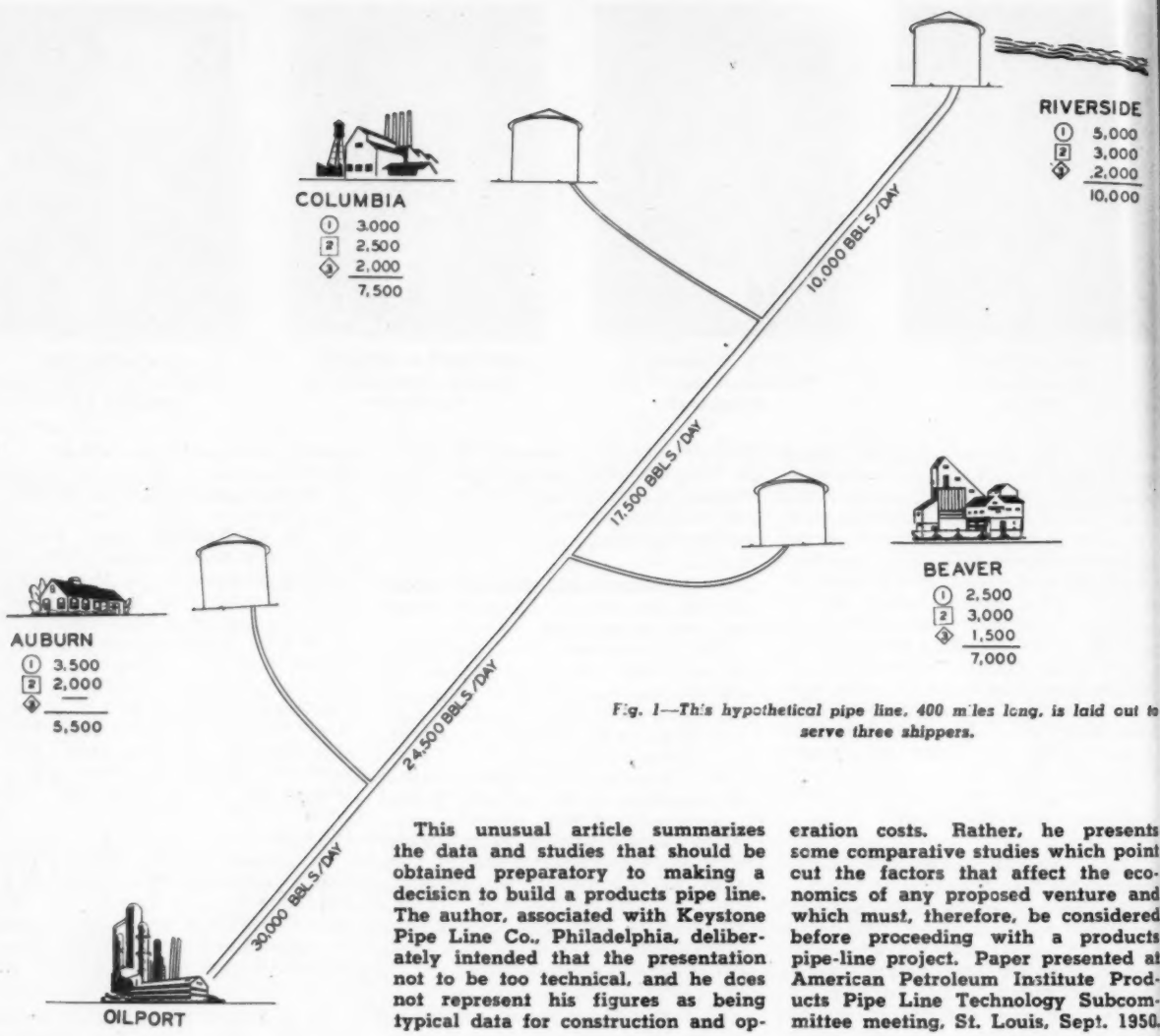


Fig. 1—This hypothetical pipe line, 400 miles long, is laid out to serve three shippers.

This unusual article summarizes the data and studies that should be obtained preparatory to making a decision to build a products pipe line. The author, associated with Keystone Pipe Line Co., Philadelphia, deliberately intended that the presentation not to be too technical, and he does not represent his figures as being typical data for construction and operation costs. Rather, he presents some comparative studies which point out the factors that affect the economics of any proposed venture and which must, therefore, be considered before proceeding with a products pipe-line project. Paper presented at American Petroleum Institute Products Pipe Line Technology Subcommittee meeting, St. Louis, Sept. 1950.

Economics of a Products Pipe Line

. . . A study of a hypothetical artery

by R. H. Lynch

WHERE a business venture represents a large capital outlay, every possible combination of the factors affecting its economy should be investigated. This is particularly important in those ventures where investment returns are comparatively limited but extend over long periods. Typical of this kind of business venture is the products pipe line. To illustrate the extent to which an economic investigation should be carried, the following study of a hypothetical products pipe line is offered.

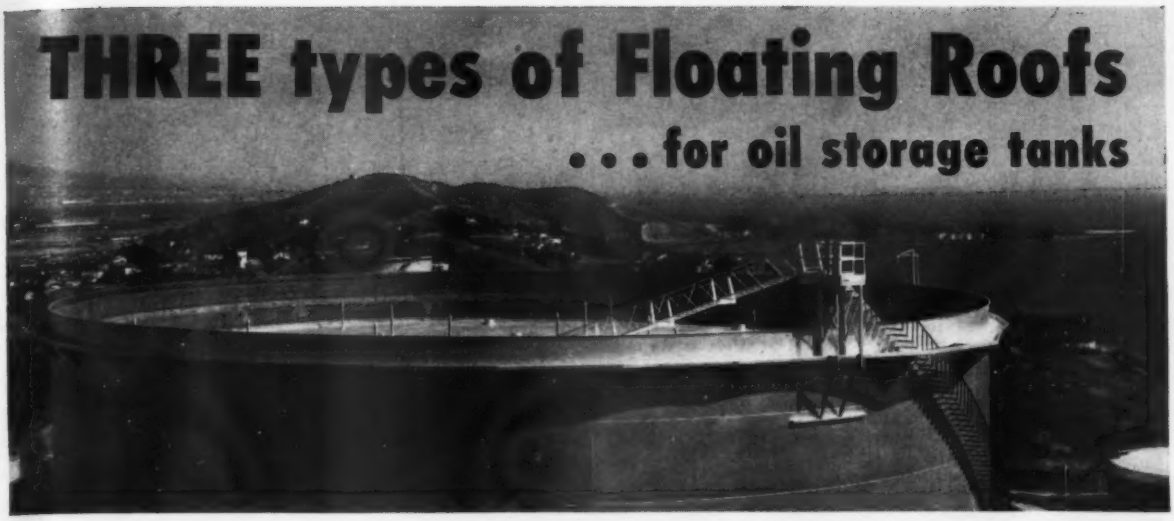
A hypothetical pipe line is shown in Fig. 1. This map indicates a 400-mile long system serving three shippers. The shippers' products are to be moved from a tide water source across a sales area to an inland water terminal with terminals at mythical towns.

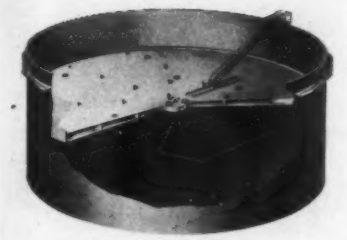
The first terminal is located at Auburn, a residential community. Another terminal is shown located at a mining center which we have named Beaver. This town is assumed to be in a mountainous area as will be shown later. The next terminal is supposed to serve a manufacturing center at a town we called Columbia.

The terminus of the line is at a terminal or terminals located on an inland waterway and has been named Riverside. All the terminals have been arbitrarily shown to be 100 miles apart to avoid complication in the presentation. The source of supply for the trade area has been called Oilport and could be a series of deep-water terminals or a refining center.

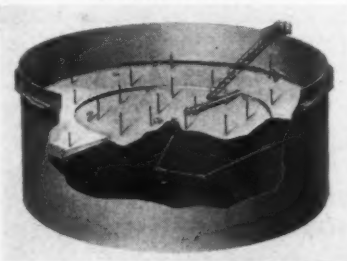
The shippers proposing to use the line are simply named 1, 2, and 3,

THREE types of Floating Roofs
. . . for oil storage tanks

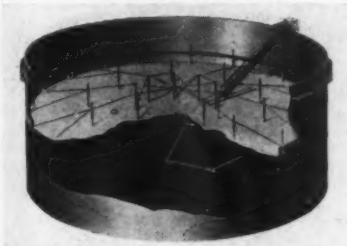




THE HORTON DOUBLE-DECK FLOATING ROOF



THE HORTON PONTOON FLOATING ROOF



THE HORTON PAN FLOATING ROOF

The Horton® DOUBLE-DECK Floating Roof

This type—most recent design of all three—embodies the best construction features gained through many years of experience building floating roofs. Double-deck construction provides an insulating air space over the entire area of the tank. It also provides maximum stability because the space between the decks is divided into a number of compartments. Furthermore, maintenance costs are low because the top deck is pitched downward from the periphery to drain at the center. This slope is adequate to provide positive drainage and thus eliminates puddles of water which would corrode upper deck plates.

The Horton® PONTOON Floating Roof

This type of floating roof has an annular pontoon ring around the outer edge and a deck of single thickness at the center. The pontoon ring provides a "double-deck" over more than half the area of the tank. If boiling occurs, the vapor that forms in the liquid is trapped under the single deck, which domes upward, forming a blanket of vapor between the liquid and the roof. This vapor blanket serves as an effective insulating medium and prevents further boiling. The annular pontoon is divided into compartments to increase the roof's stability.

The Horton® PAN Floating Roof

This roof has a deck of single thickness and a rim at the outer edge. The deck, which is coned downward toward the center, is held in that position by radial stiffeners and trusses. Pan type roofs are used for maximum economy on tanks storing liquids of relatively low volatility.

All three types of Horton Floating Roofs are equipped with the Horton Seal—one of the best devices ever developed for preventing the escape of vapor around the edge of a floating roof. All three float directly on the liquid—and thereby cut down evaporation losses, decrease corrosion, and reduce the fire hazard. Let representatives help you select the best type for your service.

® *Registered in U. S. Patent Office*

CHICAGO BRIDGE & IRON COMPANY

Plants in BIRMINGHAM, CHICAGO, SALT LAKE CITY and GREENVILLE, PENNSYLVANIA

Atlanta, 3.....2154 Healey Bldg.
Birmingham, 1.....1536 North 50th St.
Boston, 10.....1025—201 Devonshire St.
Chicago, 4.....2128 McCormick Bldg.
Cleveland, 15.....2204 Guildhall B'dg.
Detroit, 26.....1514 Lafayette Bldg.
Havana.....402 Abreu Bldg.
Houston, 2.....2119 National Standard Bldg.
Los Angeles, 17.....1523 General Petroleum Bldg.
New York, 6.....3347—165 Broadway Bldg.
Philadelphia, 3.....1615—1700 Walnut Street Bldg.
Salt Lake City, 4.....525 West 17th South St.
San Francisco, 4.....1554—200 Bush St.
Seattle, 1.....1325 Henry Bldg.
Tulsa, 3.....1606 Hunt Bldg.

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Compagnia Tecnica Industrie Petroli, Rome, Italy
Whessoe, Limited, Darlington, England
Motherwell Bridge & Engineering Company, Limited, Motherwell, Scotland
Sociedade Chibridge de Construcoes Ltda., Rio de Janeiro, Brazil

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Cooling tower algae growths are often blamed for plugged condensers and troubles in other heat exchange equipment... *At left* Nalco Microbiological Laboratories' investigations reveal the true culprits, *see text below* ...

ALGAE, the trouble-makers in cooling towers, seldom cause plugging, corrosion or iron oxide deposits in other parts of cooling systems ... Nor can mold growths, slime-forming, sulfate-reducing and iron-depositing bacteria that do cause these internal difficulties be controlled with most algae-killing chemicals.

These established facts make it obvious that proper control of microbiological growths in any cooling system is first a job for experts. Proper identification, selection of treatment chemicals and dosages, and proper points of application will be handled efficiently and economically in your plant by Nalco Field Representatives, working closely with the Nalco Laboratories. Once proper microbiological control is established, consistent supervision to check effectiveness of treatment is all that is necessary to insure clean, slime- and algae-free equipment throughout your cooling system.

Your copy of Nalco Reprint No. 6, "A Practical Approach to the Problem of Cooling-Water Slime," will be sent promptly upon request ... If your slime and algae control problem requires corrective action, now, write or call for a Nalco Field Representative.

FORMULA FOR SUCCESSFUL SLIME AND ALGAE CONTROL

- Identify slime-forming organisms to be controlled.

A NALCO SERVICE

- Determine the best types of treatment to be used.

A NALCO SERVICE

- Determine, by detailed survey, the proper method of application.

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- Provide consistent supervision to check application and effectiveness of treatment.

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NATIONAL ALUMINATE CORPORATION
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THE *Nalco* SYSTEM • Serving Industry through Practical Applied Science

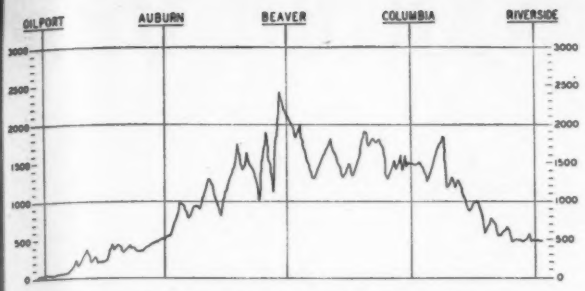

Fig. 2—Profile map of the hypothetical pipe-line route.

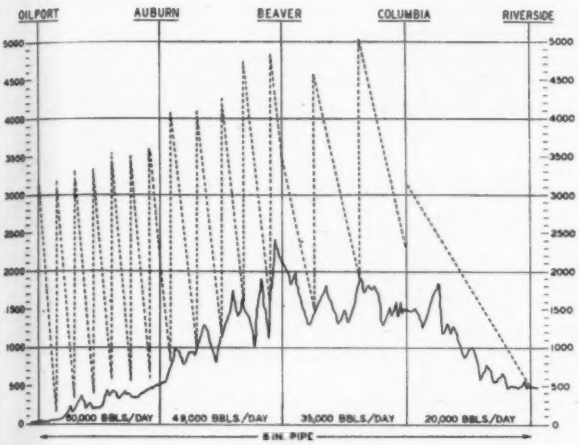

Fig. 4—Plan A, hydraulic data, 60,000 bbl. per day.

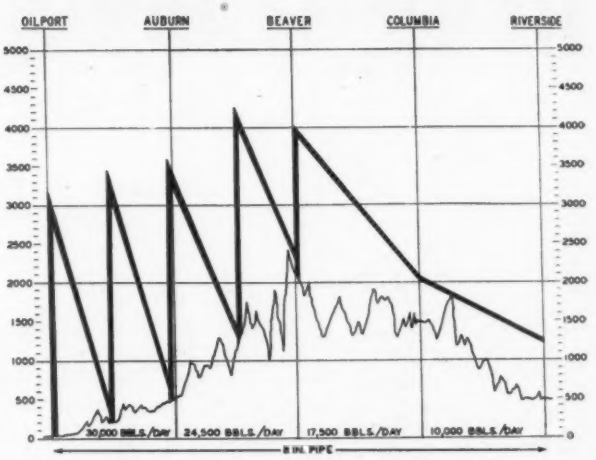

Fig. 3—Hydraulic data, plan A, 30,000 bbl. daily.

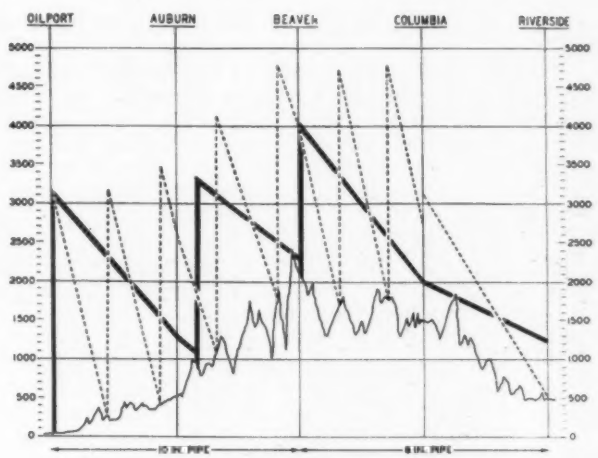

Fig. 5—Hydraulic data, plan B.

and Fig. 1 shows the volume in barrels per day required by each shipper at the terminal points. From these figures, by addition, the total demand for each terminal is obtained. In the same manner the total volume in barrels per day for each section of the line can be determined. This also appears in Fig. 1.

Layout of Pipe-Line Route

Having this information, we then proceed to lay out the pipe line on U. S. Geological Survey sheets. Having mapped the proposed route, a profile can be prepared by reading the contour lines from U.S.G.S. maps and plotting the elevations. The proposed route of the pipe line is laid out on the maps so as to have the terminal locations in a satisfactory position for truck or rail distribution from these points.

If existing terminal sites are to be connected, the line must obviously connect to these locations. If new terminals are to be built, then the desires of the shippers in this respect must be ascertained and either satisfied or acceptable compromises obtained. Fig. 2 shows the profile obtained by plotting the elevation taken from the U.S.G.S. maps.

With the use of graphs the hydraulic data can be shown on the profile and thus we can determine the number of pump stations required for a given rate of flow. (See Fig. 3.) The hydraulic gradient (that is) the slope of the graph from pump station to pump station is determined for the size of pipe, the liquid flowing, and the rate of flow and is readily obtainable in almost any textbook on the subject. All of the accepted methods are simply a variation of the original D'Arcy formula.

The data presented here have been obtained with a Hazen & Williams slide rule, using a "C" factor of 150. These figures are simply the friction loss which occurs in a smooth pipe because the liquid is flowing through the pipe. The "C" factor is a value which reflects the relative smoothness of the interior of the pipe. You can see that it is also possible to obtain the pressure of the flowing liquid at any point on the pipe line by measuring the distance from the profile to the gradient.

Plan A

The hydraulic data for an 8-in. pipe line at 30,000 bbl. per day is shown on Fig. 3. The upright shaded lines represent the location of pumping stations operating at 1,000-psi. pressure and 30,000 bbl. per day throughput in the initial section, 24,500 bbl. per day through the second section, 17,500 bbl. per day through the third section, and finally, 10,000 bbl. per day through the last section.

This volume which represents the shippers' requirements at the time the line is first put in operation would be a relatively easy job for an 8-in. line, requiring five pump stations to move the required volumes, and this probably would be a financially satisfactory design. But experience has shown that most products lines can look for a 100 per cent increase in business in 8 to 10 years. Now, if we project this increase in sales of products 10 years ahead, then the hydraulic requirements of an 8-in. line at 60,000 bbl. per day produce the formidable picture shown on Fig. 4. You will notice that quite a few pumping stations are required.

Plan B

This immediately suggests larger-diameter pipe, at least part way, so we increase the first two sections, that is to say, the first 200 miles of the line, to 10 in., the balance remaining 8 in.

As you can see from Fig. 5, at

OVER $3000 SAVED ON ONE

CENTRAL LEDUC OILS LIMITED
CALGARY, CANADA

Gentlemen:

Almost seven months ago we installed Winslow Filters on a Waukesha XAH engine, to protect both the natural gas on which the engine operates and the lubricating oil which safe guards its moving parts. We feel sure that every economy-minded engine operator would like to share the savings and improved performance which we have enjoyed as a result of this Winslow installation.

The best way to describe results is to give you actual figures:

Before these filters were installed, we had to have the engine rebuilt every six weeks, an overhaul job that cost $290. We had no gas filter but did have another make of lube oil filter, and the life of both the filter and the oil itself was 168 hrs. This was also the life of our spark plugs, but they had to be cleaned every day and they were useless after those 168 hours.

After we installed a Model 14-1645-GS Winslow Gas Filter and a Model 1960 Winslow Lubricating Oil Conditioner, it was as though we had a completely different engine. Operating the engine continuously, 24 hours a day, we were able to go 1,000 hours before changing the lube oil and the lube oil filtereelements. We had 4,728 hours, or 197 days, of service from the gas filter elements before changing them. We cleaned the spark plugs every 22 days, and they lasted an average of 75 days before needing replacing. And most significant of all, when we tore the engine down after six and a half months of steady operation, we found only a small scuff on one bearing, all the other bearings were perfect, the crank shaft was perfect, the rings were free, there was no scoring on the cylinders, and there were no sulphur deposits around the valves or spark plugs.

We estimate that on this one engine, Winslow Filters saved us a total of $3,264 in those six and a half months, including the costs of engine overhauls, lube oil changes, servicing, shutdowns, spark plugs, etc. In addition, it would have cost us another $5 a day if we had had to operate on gasoline.

In our opinion, an engine operator who wants efficient, dependable, low-cost performance should not be without Winslow Filters.

Sincerely yours,

CENTRAL LEDUC OILS LIMITED
A. Addison
Field Superintendent.

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WINSLOW ENGINEERING COMPANY

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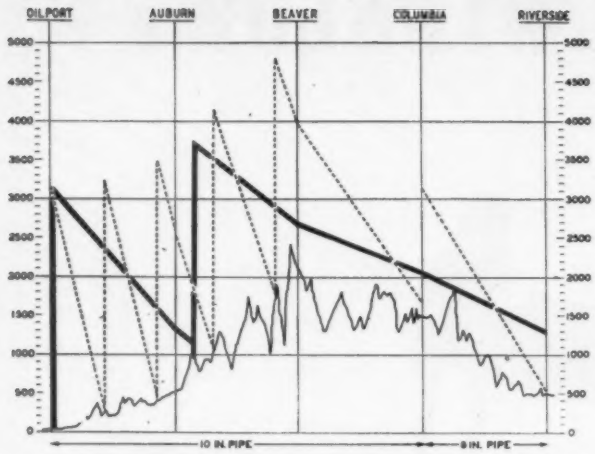

Fig. 6—Plan C, hydraulic data.

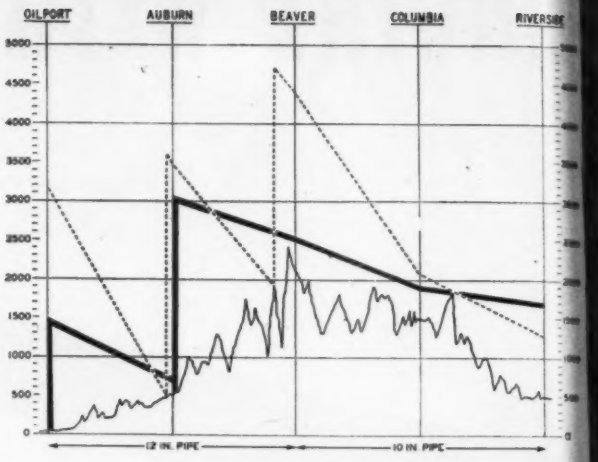

Fig. 7—Hydraulic data, plan D.

30,000 bbl. per day this plan would require only three pump stations, but at 60,000 bbl. per day, we would still need eight pump stations to handle the average volumes.

Plan C

Continuing the 10-in. pipe to the third terminal, that is, 300 miles of 10-in. and the last remaining 100 miles at 8-in. pipe size, produces a system which reduces the pump stations required initially to two. At 60,000 bbl. per day there would have to be six pumping stations. (See Fig. 6.)

Plan D

As a final step in this hydraulic study, let's take a look at 12-in. pipe for the first two sections, that is, 200 miles, and 10-in. pipe for the other 200 miles. This would require only two pump stations for the initial volume, and three pumping stations for the 60,000-bbl. per day business. (See Fig. 7.)

This decrease in stations is all very well, but the larger-diameter pipe and its construction cost more money, too, and there must be a proper balance between the two.

Costs and Return

So, let's take a look at the financial picture of these various schemes. For the 8-in. system we have estimated amounts of money shown on the chart for various barrels per day of throughput. The figures on the abscissa are expressed in barrels per day of throughput. The ordinates are in dollars per year. (Plan A, Fig. 8.)

The depreciation charges are an almost fixed amount of money, but, if you look closely, you will see that it increases somewhat as the throughput goes up. This is due entirely to the increase in investment because of the increased number of pumping stations. Depreciation has been figured at 5 per cent and the numbers used are those for the depreciation in the first year of useful life.

Pipe-line-maintenance costs are plotted at a fixed rate on the assumption that maintenance of the pipe line itself (exclusive of pump station and similar equipment) costs the same at 10,000 bbl. per day as at 60,000 bbl. per day.

Operation costs as plotted reflect the increase in power costs for the higher volumes, increase in personnel required to operate the additional pumping stations, and increased mechanical maintenance costs for the additional pump station and delivery facilities.

Administration costs have been figured on a flat percentage of operation and maintenance costs combined.

Transportation taxes (a federal impost) have been calculated at 4½ per cent and vary directly with the volume pumped.

All other taxes have been lumped together and include real estate, local, state, and federal taxes, which are of the nonvariable (that is, fixed) type.

Federal income taxes have been figured from the point at which the project begins to earn net income and assumes enormous proportions as the income increases.

You will notice that this chart shows the pipe line must move about 12,000 bbl. per day to pay its operating charges. This point is sometimes referred to as the "break even" point. At 30,000 bbl. per day there would be $630,000 earnings at the end of the year for use as dividends or interest on the investment, depending on the method of financing the venture; and at 60,000 bbl. per day

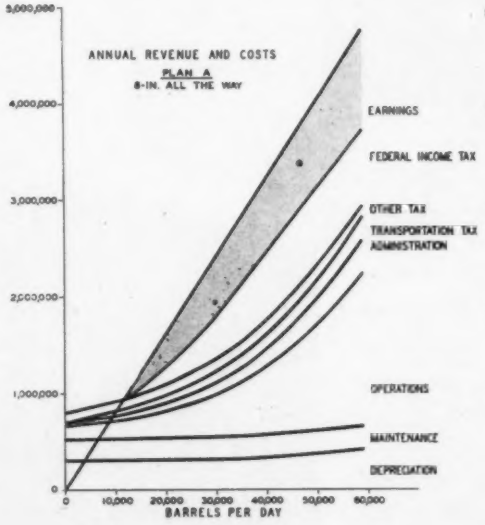

Fig. 8

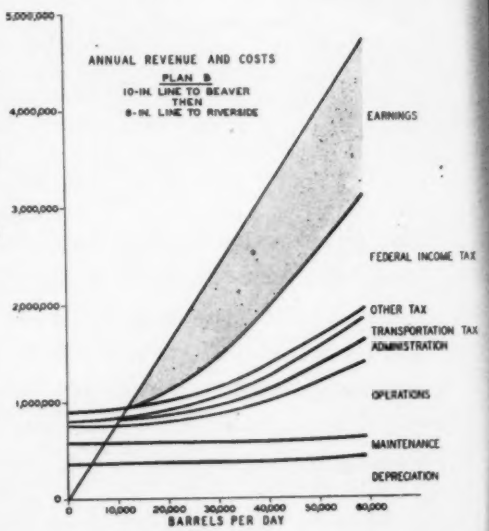

Fig. 9

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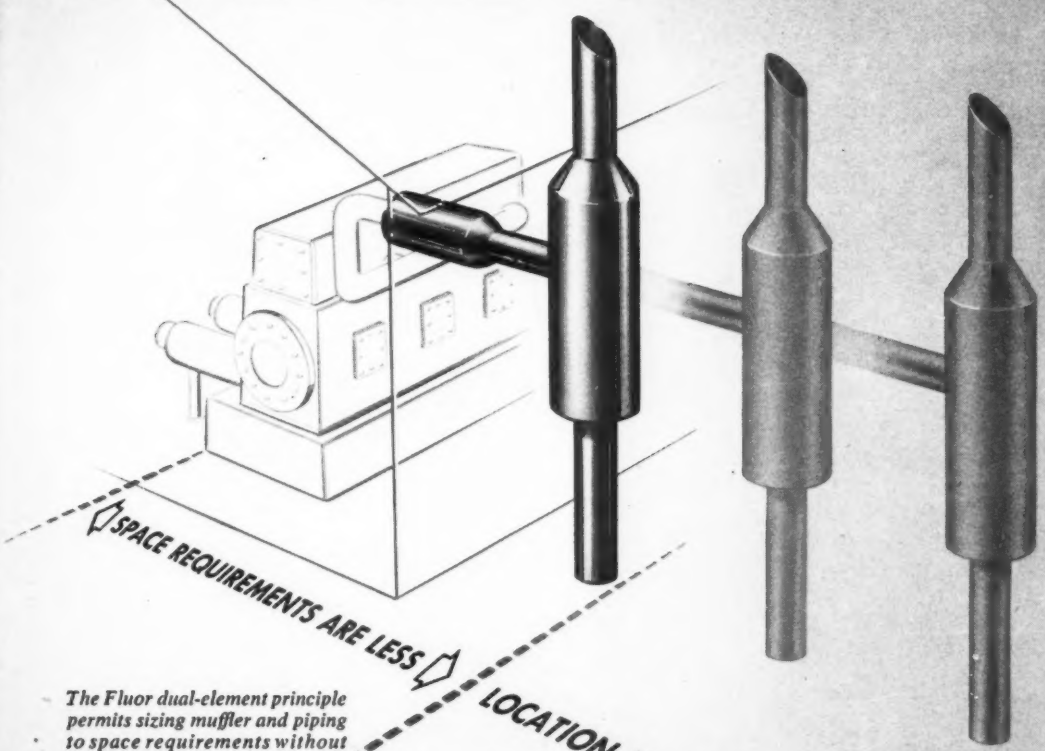
See for yourself...

the installation advantages of a FLUOR SERIES "D" MUFFLER SYSTEM

NO LONGER is ultimate muffling efficiency dependent upon trial-and-error locating of exhaust piping. With the Fluor Series "D," exhaust piping can be of *smaller* diameter, location of outside exhaust chamber *flexible* without affecting pressure drop or noise attenuation and pulsation reduction efficiency.

The reason lies in the unique dual-element design of this muffler *system*. Work is started on pulsative exhaust gases *at* the engine—noise and pulsation reflections are virtually eliminated *at* their source. The Fluor Series "D" Muffler is a *system* that incorporates *two* muffling elements—a primary element located in the immediate proximity of the engine and a secondary element located *at any desired spot* outside the engine room.

The Fluor Series "D" Muffler System is the answer to your muffling problems. In addition to installation flexibility it provides the highest muffling efficiency obtainable—*at a cost competitive with conventional mufflers.*



The Fluor dual-element principle permits sizing muffler and piping to space requirements without setting up hazards common to single-element mufflers.

All elements, including interconnecting piping, are engineered to a minimum in diameter.

Because muffling is spread throughout a Fluor Series "D" System, the outside muffling chamber can be set at any desired distance from the engine room wall.

AVAILABLE FROM STOCK—A Fluor Series "D" Muffler System to fit virtually any 2- or 4-cycle, 200 to 2400 HP diesel engine is available from stock. You need only submit engine room design and dimensions, make, model and RPM of engine and whether muffling system is to be air-cooled or non-air-cooled. Inquiries will be answered promptly.

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Above: Five of the fifteen Cooper-Bessemer GMW engine-driven compressors in Michigan-Wisconsin Pipe Line Company's Guymon-Hugoton Station, showing units from scavenging blower end. Each has 10 power cylinders and drives 3 compressor cylinders.

Right: Five GMW's in Transcontinental's Saint Francisville Station.

Extreme Right: Two of four GMW's in Panhandle Eastern's Liberal, Kansas Station.

ANGLE V

Compressors

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efficient COMPRESSOR

MAYBE you've been thinking about compressor sizes and types you'll be needing for jobs ahead. You are aware that new developments in the oil and gas industry require you to study carefully the advantages and disadvantages of all types of equipment. Of one thing you can be sure . . . the GMW compressor unit (a recent development in itself) takes *full* advantage of the biggest strides made in gas engine performance. So in your planning weigh and compare these significant facts:

FUEL EFFICIENCY

1. The GMW is the only gas engine that guarantees fuel consumption of 7500 BTU's per BHP/hr. This means that the fuel you save operating these engines is delivered to the consumer . . . additional profit for you!

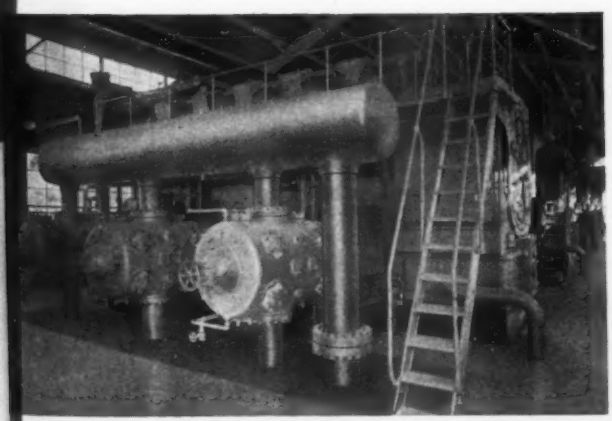
INSTALLATION EFFICIENCY

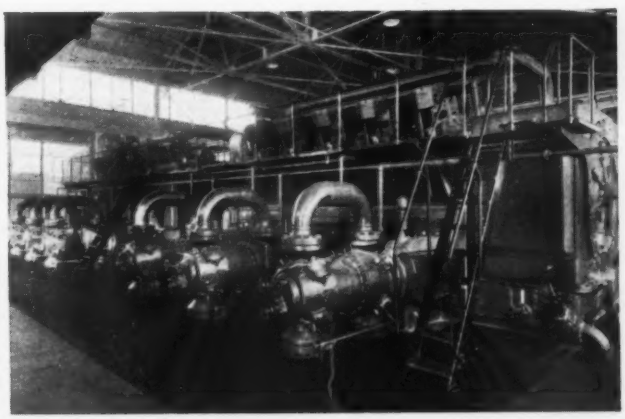
2. On installation, piping, housing, over-all operation, and maintenance you can save plenty with the GMW the largest angle compressor built. It offers the lowest *space-to-power* ratio of any gas engine driven compressor unit today, necessitating fewer units on gas transmission lines.

SMALLER COOLING TOWERS

3. Extra savings, big ones, are assured on the cost and installation of cooling equipment and piping alone, *because the GMW has the lowest heat dissipation of any gas engine compressor unit on the market today!*

These are just a few of the *major* economies you'll gain with modern, long-lived, low-maintenance GMW's. If your plans call for compressor power from 1500 bhp up, get *all* the facts . . . ask the nearest Cooper-Bessemer office to give you specific performance figures and estimated savings based on your particular requirements.





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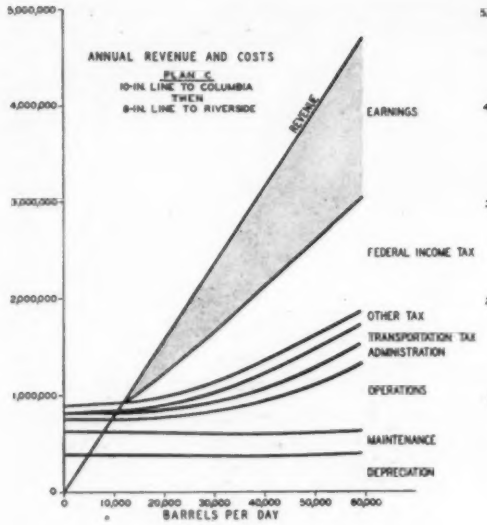

Fig. 10

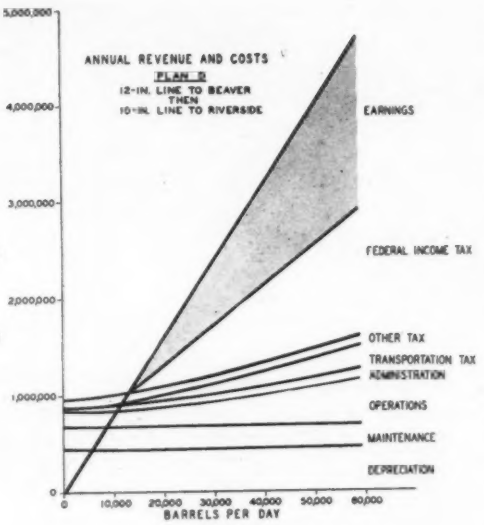

Fig. 11

there would be $1,077,000 left for these purposes.

In order to draw even this preliminary chart considerable thought must be given to the line representing "Revenue." This could be considered as the end result of the study—that is, how much must we charge in our tariff to earn a fair return on the investment. On the other hand, the tariff rate may be set by other circumstances, mainly competition from other lines, or waterways. We have used a figure of 8 cents per 100-bbl.-mile for calculating the revenue of our theoretical line. This seems reasonable to meet competition and realize a fair return.

Following a similar approach to that made for Plan A, we see in Figs. 8, 9, 10, and 11 the costs of all four of the proposed schemes. You will note that at 30,000 bbl. per day Plan A returns $630,000; Plan B, $708,000; Plan C, $716,000; and Plan D, the 12-in. and 10-in. line, $681,000. At 60,000 bbl. per day, however, the more large-size pipe the better, for Plan A returns $1,077,000; Plan B, $1,614,000; Plan C, $1,708,000; and Plan D, $1,842,000.

Return on Invested Capital

While we have included the effect of increased plan investment on the depreciation account, still we have not applied the real yardstick of our economic system—per cent return on the invested capital.

Figs. 12 and 13 show that our least possible investment would, of course, be for an 8-in. line, but that the addition of pumping stations would cause this to surpass the cost of Plan B at about 51,000 bbl. per day, and Plan C at 55,000 bbl. per day.

The per cent return on this minimum investment would not be so attractive, for right in the neighborhood of our expected starting value, the per cent return of Plan A falls below that of Plans B and C, and is below even the most expensive plan by the time the volume reaches 40,000 bbl. per day.

Plans B and C appear to offer a choice which might well be based on entirely foreign considerations, such as, availability and relative cost of electric power, terrain, and accessibility of pump-station sites, or even the method by which it is expected to finance the entire project.

Plan D serves two purposes: It represents an upper limit to the reasoning applied to this entire study, and it gives an indication of what could be realized should the possibility of new shippers and increased volumes be so great as to make the added initial investment desirable.

So, we see it has been possible to put our proposed line into a series of graphs which help us to see the relative financial merits of the various schemes of design and operation. By this means we have eliminated the first plan, offered a choice of two other plans which will produce practically the same percentage return over the foreseeable future, and indicated a fourth plan which may warrant consideration.

The actual selection of the final scheme remains a matter calling for the exercise of the faculty of business judgment, which some men have and some men don't. Unfortunately, we don't seem to be able to put business judgment on a graph.

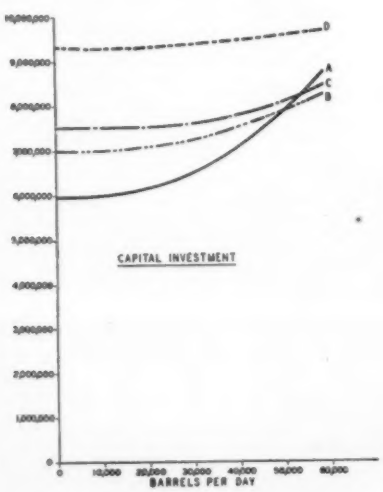

Fig. 12

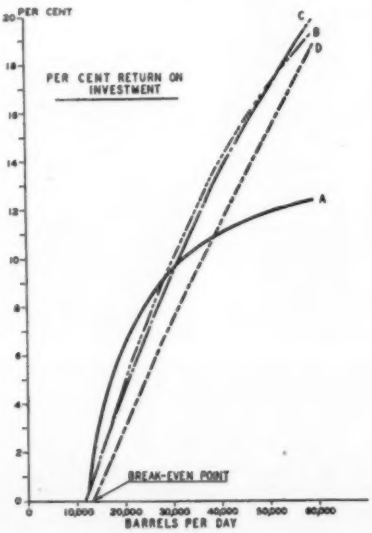

Fig. 13

Refineries Go "Prefab"

PROGRESS.—A prefabricated catalytic cracking plant now offers small refiners the opportunity to manufacture high-octane gasoline with a relatively small investment. The plant is prepared in units and shipped by rail. Complete plants can be erected within 180 to 240 days after a contract is let.

New Idea in Tank Transport

PROGRESS.—The task of moving a bulky 3,800,000-gal. storage tank to a new location didn't faze one refining company. A bulldozer scooped out a ditch 1,000 ft. long and 2 ft. deep. Water from a nearby pond was pumped into the miniature canal. The tank was floated to its new site.

The staff of REFINERY ENGINEERING Company thought a refinery need not be just a jungle of pipes and valves and vessels. It could be as appealing as other manufacturing plants, and should have something to attract the favorable attention of the public.

With this in mind, Treco engineers designed the first refinery with "picture windows". The control room was placed as near as possible to a main highway.

Large areas of plate glass permitted the public to look in and the public has been looking into this nerve center of operations—in extraordinary numbers. This has proven to be such an important public relations gesture that you will see more progressive refiners adopting it. Treco will announce others soon.

Show the public the "inside workings" of your business. Let people know how your product is made. Show them a modern, clean and highly efficient plant and you will gain their loyalty. And, get in touch with REFINERY ENGINEERING Company right away, for information on how your plant can be improved to do a better production as well as a better public relations job.

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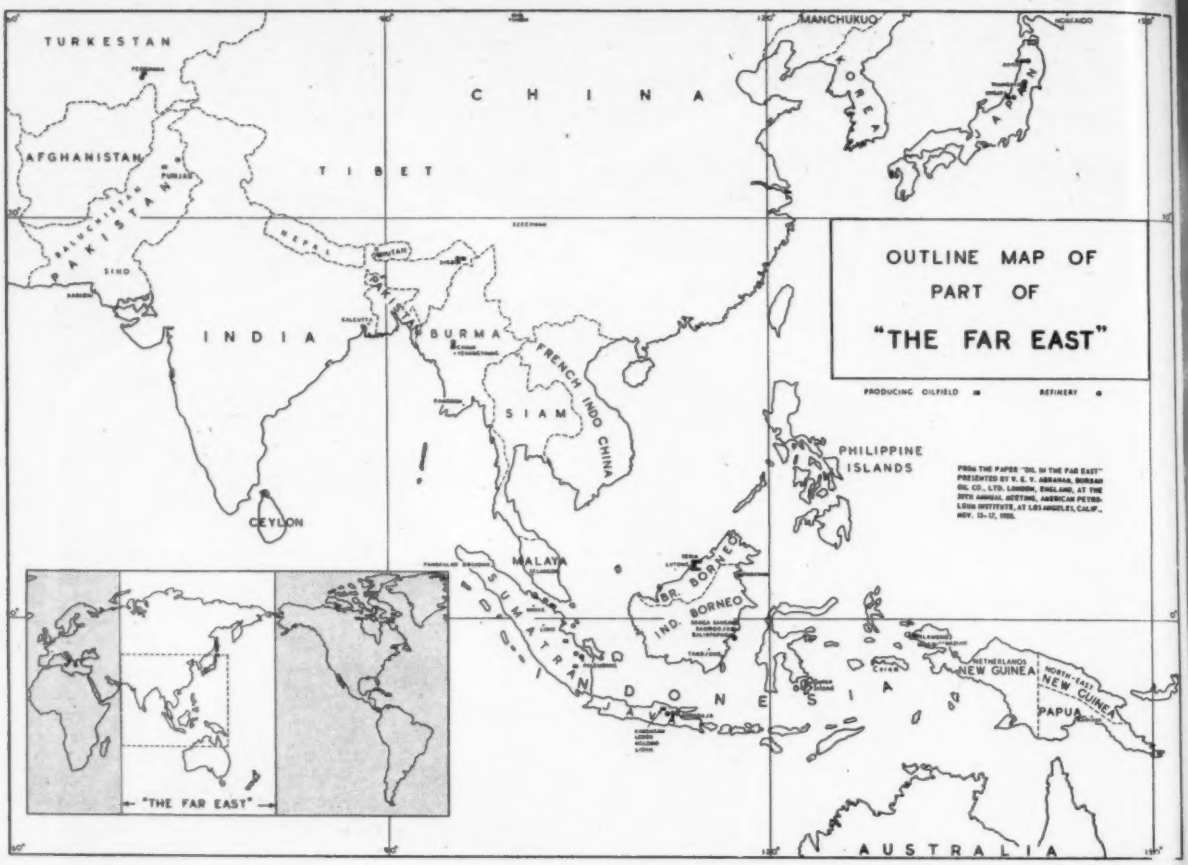

What's the present picture on

OIL IN THE FAR EAST?

by W. E. V. Abraham

This article offers data and speculative opinion of great global interest and importance on the existing situation and the possible future in all countries which lie east of the Urals and the Persian Gulf and west of the Americas—including Asiatic Russia, India, Pakistan, Indonesia, Japan, and Australasia. History and the results of exploration are touched upon, as well as the status of new and old friends and the transportation and refinery situation.

The incredibly low per capita petroleum consumption throughout most of this region (which comprises more than one-third of the land surface of the earth and contains more than one-half of the world's population) is referred to in the light of existing reserves and the probable future relationship between production and consumption.

IN this article the Far East is defined as including all the world which lies east of the Urals and the Persian Gulf and (except for a few small islands) west of the Americas. This area will, therefore, include, on the west, Afghanistan, Pakistan, and India; and, on the east, Japan and Australasia. This huge area, about one-third of the globe, includes some 35 per cent of the world's land surface and more than half of the world's population.

Consumption in the Far East

Most of us are familiar with the astonishing fact that (roughly speaking) two-thirds of the world's oil production is consumed by 150 million Americans and one-third by the 2,000 million inhabitants of the rest of the world. We are also accustomed to state, as a generalization, that the Far East is the great unsaturated oil market of the world. In spite of this, it may come as a surprise to some of us that that half of the population of the world which lives between the Urals-Persian Gulf and the Pacific consumes less than one-twentieth of total world consumption.

The total Far East consumption of about 120 million barrels represents less than 5 gal. per year per head of population, as compared with a corresponding figure for the United States of almost 600 gal. It is, therefore, hardly too much to say that (with certain exceptions such as Australasia) the Far East, as defined here, has hardly begun to use oil in the sense it is used in America. If every human being between the Urals and Pacific consumed, on the average, even one-tenth as much as an average person in the United States,

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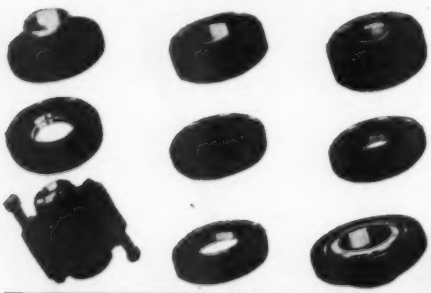

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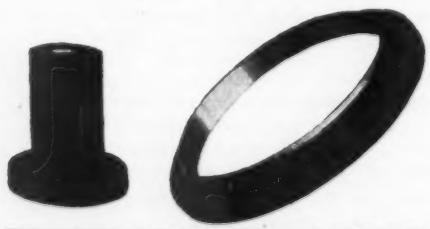

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STATISTICS ON AREAS OF THE FAR EAST

	Area (thousands of sq. mi.)	Population (millions)	Estimated 1949 consumption (millions of bbl.)	Annual oil consumption per head of population (U. S. gal.)
Australasia	3,079	10	32	134.4
India, Pakistan, and Ceylon	1,930	416	28	2.8
Asiatic Russia	8,245	42	17*	17.0
Japan	263	78	11	5.9
Siam and Malaya	248	23	7	12.8
Philippines	115	19	10	22.1
China, Tibet, and Mongolia	4,314	467	7	0.6
Remainder	1,582	137	10	3.1
Total	19,776	1,192	122†	4.3(?)

*No estimate available. The figure given here is the estimated production. Consumption may be somewhat larger than this. †Consumption figures in this table exclude bunkers.

the annual Far East consumption (if and when the oil could be made available) would jump from about 120 million to about 1,800 million barrels.

Far East Production

One might have thought that the very small present demand (in relation not only to population, but to square mileage involved) could have been met by oil produced from different places within this huge area. Such is not the case. Production from all sources between the Urals-Persian Gulf and the Americas amounts to not much more than one-fortieth of total world production. The main producing countries are:

	Millions of U. S. bbl. (1949)
Indonesia	42
British Borneo	25
Asiatic Russia (incl. Sakhalin)	17
Remainder	7
Total	91

Reports by Areas

The first question which must strike anyone, on seeing these figures, is whether this very small oil production from such a very large part of the earth's surface is due fundamentally to lack of rich oil deposits or to a failure, for whatever reason, up to the present to explore the possibilities at all thoroughly. This question can be best answered by dealing with the different areas separately.

Afghanistan.—No oil is produced; but oil indications have been reported from the northern provinces, immediately to the north of which there are the small Russian oil fields of the Ferghana Valley. So far no tests have been drilled, and any developments are likely to come from the Russian side. Geological investigations have not suggested that there are any prospects of obtaining oil in the more southerly part of the country, bordering Pakistan.

Pakistan, India, and Ceylon.—As we pass from the Persian Gulf into the Gulf of Oman, we also pass abruptly and surprisingly from the Middle East petroleum region into an entirely different geological province, both as regards lithology and type of folding; and this change is strikingly reflected in relatively poor oil discoveries and prospects.

Oil of Eocene age is produced in a few oil fields (Khaur, Dhulian, Balkassar) in the province of the Punjab, in western Pakistan; and more of these small fields, of the order of 5 million barrels each, may remain to be discovered. Further west, in Baluchistan, there appear to be possibilities of somewhat bigger oil fields, and preparations for testing are in hand. The Sind Valley, near Karachi, has been carefully surveyed geophysically, but a recent deep test in this region gave completely negative results.

In the main mass of peninsular India and in Ceylon, no oil possibilities exist. North of Calcutta, Ganges delta has been surveyed geophysically—with disappointing results. Farther east, in eastern Pakistan and the adjoining part of India, there are possibilities of small oil fields. Still farther to the northeast, Digboi oil field, now 60 years old, has produced some 5,000 bbl. per day for the past 20 years, from rocks of Miocene age. A large number of test wells have been drilled without proving oil in any neighboring structures, but there is still a slight hope that some further oil will be discovered. Aggregate production to date from the whole of the subcontinent of India plus Pakistan is only about 60 million barrels. All oil so far discovered is processed in small local refineries.

Burma.—Burma has produced to date 250 million barrels of oil, mainly from the two fields of Chauk and Yenangyaung, of which the latter passed its peak many years ago. The oil rocks are of Miocene and Oligocene age. Oil was formerly piped 300 miles from the oil fields for refining near Rangoon, but political unrest has made impossible repair and operation of the pipe line. As a result, work on the rebuilding of the Syriam refinery near Rangoon has stopped; and oil production, for local marketing, is less than 2,000 bbl. per day, all from Chauk field.

Prior to the war many test wells were drilled in the hope of discovering new fields in Burma, but all without any success; and, although there is still some testing to be done, when political conditions permit, it seems on the whole unlikely that Burma's production rate will in the future be as high as the prewar rate of about 20,000 bbl. per day.

Siam and Malaya.—The stratigraphic sequence in these countries is estially Paleozoic, Triassic, and Pelistocene. Oil shales exist, but the chances of obtaining crude oil are nil.

French Indo-China.—Formations younger than the Triassic are here dominantly continental; and, although some oil indications have been reported, no significant accumulations are to be expected.

Sumatra.—Oil production in Sumatra dates from 1893. The oil occurs in rocks of Pliocene and Miocene age; and the oil basin, stretching all the way along the eastern coast of the island, can be considered in terms of three separate sub-basins.

In North Sumatra 12 fields have produced oil in commercial quantities, total production to date being almost 160 million barrels. The oil used to be refined locally at Pangkalan Brandan; but this refinery was completely destroyed during and after the war, and the political situation has so far prevented resumption of normal production and refining operations in this part of the island.

Oil is present also in Middle Sumatra; but exploration is difficult because of swamps and Quaternary plains, and fields are still in an early stage of development. A small field, proved prewar at Lirik, will probably be worth 7,500 bbl. per day. Another prewar discovery not yet developed is at Minas.

In South Sumatra 43 fields have yielded a total production of almost 475 million barrels. Rehabilitation since the war has in this area been so successful that 1950 production will exceed the prewar level of 85,000 bbl. per day. Exploration has been resumed. South Sumatra oil is processed in two refineries at Pladju

THE AUTHOR

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This paper was presented at the A.P.I. thirtieth annual meeting in Los Angeles, November 9-17.

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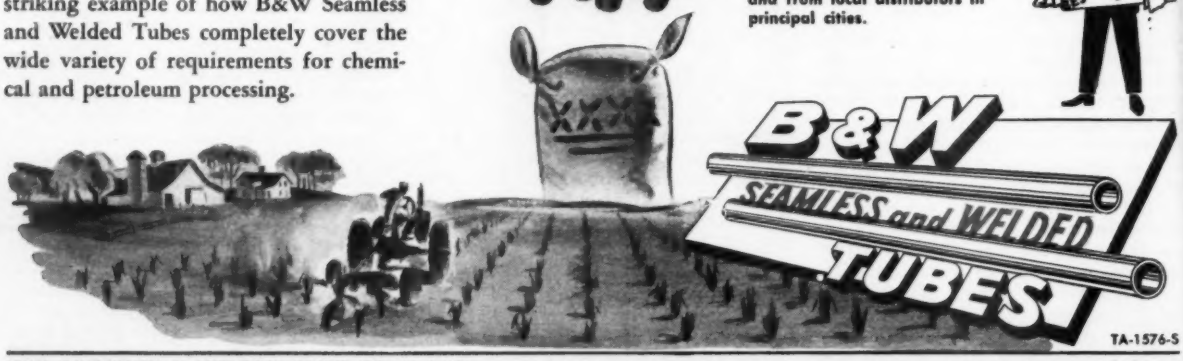

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and Sungei Gerong (near Palembang).

Java.—Oil occurs in the Pliocene and Miocene, and production in Java dates back to 1895. The principal fields—most prominent of which are Kawengan, Ledok, Nglobo, and Lidah—are concentrated within a rather small area in the eastern part of the island, where a cumulative production of almost 120 million barrels has been obtained.

Prewar production was about 6 million barrels per year; but poltical unrest has retarded rehabilitation, and 1949 production was only about half a million barrels. This was refined in a small unit in Surabaja, and used for local consumption.

Extensive exploration, carried out before the war in the western part of Java, has not yielded any promising results.

Indonesian Borneo. — Oil activities on the east coast of Borneo started in 1897; and production, from Pliocene and Miocene strata, aggregates to date almost 430 million barrels—chiefly from the fields of Sanga Sanga, Sambodja, and Tarakan. Production from existing fields is now on the decline, but exploration is continuing.

All East Borneo production, except that from Tarakan which is marketable as produced, is refined at Balikpapan.

Remainder of Indonesia.—Oil production in the islands between Borneo and New Guinea up to now has been very small, and the chances of obtaining any appreciable production in the future are remote.

The island of Ceram produced, between 1897 and 1941, a total of about 8 million barrels, from Pliocene and Triassic formations; but activity there ceased after the war. The island of Buton yields asphaltic bitumen.

British Borneo. — Miocene production from the oil field of Seria, on the northwest coast of British Borneo, has increased from a prewar figure of about 15,000 bbl. per day to almost 70,000 bbl. per day in 1949, and this is now the most promising individual oil field in the whole of the East Indian archipelago. Oil is refined in part locally (at Lutong), and the remainder is shipped to other refineries. Seria has been producing only since 1929; but the older field of Miri, now on the pump, has been producing since 1911. Exploration is continuing in the hope of finding further fields.

Netherlands New Guinea.—Following incidental and scattered investigations by the government geological survey and by private companies, oil exploration in New Guinea started on a large scale in 1936. Production so far is limited to the Vogelkop in the westernmost part of New Guinea, where Klamono field, with a production of almost 5,000 bbl. a day from Miocene limestone, has been in operation since 1948. Two further anticlines (Wazian and Mogoi) in the southeast Vogelkop were proved prewar, but have not yet been developed. Exploration continues.

Papua.—The folded zone of Papua contains numerous seepages of oil and gas, and exploration borings have been drilled at various times from 1912 onwards. Intensive exploration started just before the last war, and five wells have since been drilled—including one at Kariava to 12,621 ft.—but with negative results except for minor gas and oil shows. Structural conditions are complex in the folded zone, and reservoir rock characteristics are rather unfavorable. Exploration is now proceeding in an area of more gentle folding, with a possibility of porous-reef limestone development; and, although the final results of the project as a whole cannot be judged at present, the outlook does not seem very hopeful.

Australia.—Search for oil in Australia has been going on for almost 50 years—with, so far, no real success. There is one very small field (or perhaps one ought to say one large seepage) at Lakes Entrance, Victoria, near the southeast tip of the continent, where the production is of the order of 5 bbl. per day of heavy oil with much fresh water, and horizontal drilling is in progress from the bottom of a vertical shaft into which this oil drains. Oil shows, but no commercial production, have been encountered in exploration wells at Roma in southern Queensland. An annual production of about 78,000 bbl. is obtained by distillation of oil shale at Glen Davis in New South Wales.

Exploration activity has been widely spread over the continent, and large concessions have been granted in western Australia, central Australia, and Queensland; but, in view of the lack of success so far, the outlook can hardly be considered promising.

New Zealand. — In spite of very considerable testing by the drill, oil production from New Zealand has been negligible (less than 2,000 bbl. a year recently). Such as there is has come from one small oil field (Moturoa) in the Taranaki area of North Island, from which shallow hand-dug oil was produced as long ago as 1866. Recently two better wells have been reported from this field, but the chances of major production appear remote.

Philippines.—Although surface oil and gas indications are known, and although there are several Tertiary folded bains which might be considered favorable for limited oil accumulation, the chances of major production in the Philippines are negligible.

Japan. — Japan has produced oil since the 1870's, but its cumulative production to the end of 1949 was only about 95 million barrels, with a peak of 3 million barrels in 1915 and a production of not much more than 1 million barrels in 1948. Since then there has been a small increase, which may perhaps continue inasmuch as deeper horizons remain to be tested in several of the producing areas. The oil occurs in central Hokkaido and along the coast of the Sea of Japan in the Akita, Yamagata, and Niigata areas from Pliocene and Miocene formations. The chances of finding commercial oil pools in southwestern Japan are remote.

Present production, which is entirely refined in Japan, meets only about 10 per cent of Japan's consumption of petroleum products, and it seems unlikely that this percentage will ever be increased very much.

Korea.—The chances of finding oil in Korea are negligible.

China. — The only producing oil field in China is at Yumen in Kansu Province, where development has been much retarded by inaccessibility and inadequate equipment, and production is only about 2,000 bbl. per day. The field does not appear to be individually important in size; but, as it occurs in a large folded zone, there is good reason to suppose that a number of similar oil fields will eventually be discovered in that region. Elsewhere in China large sedimentary basins, with oil and gas indications, cover an area of some 300,000 sq. miles; and, although drilling has been carried out with negative results—in Szechwan Province, for example—there undoubtedly remains more than a possibility that a really intensive search, if and when made, will produce important results. As things are now, it seems most unlikely that China will be able to satisfy more than a minute fraction of its total oil requirements for many years to come.

Asiatic Russia.—Last we come to the huge area—more than 8 million square miles—of Asiatic Russia.

First there are some small Tertiary fields, both proved and still to be proved, on the eastern border of the Caspian; but although, strictly speaking, these are just in Asiatic Russia, they are so closely linked with the Caucasus fields that I think it better to exclude them from this review.

Next there are the Tertiary fields in the Ferghana region in Turkestan, north of Afghanistan, production from which is believed to be of the order of 7 million barrels a year. Further small fields probably remain to be discovered in this region, perhaps in conjunction with small fields which may be discovered across the border in Afghanistan; but the ratio of oil won to feet drilled is likely to be low, and total production is not likely to show any very notable increase.

Tertiary oil fields in Sakhalin are believed to produce some 7 million barrels of oil per year, and here again no spectacular developments are probable.

Palaeozoic oil is produced in the Taimyr peninsula, in the extreme north of Siberia. Production is al-

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most certainly very small, but there have been reports of much activity in this part of the Arctic Circle recently, and it may be that intensive efforts to increase production are being made. No big increase is likely to be possible — as production per well, and per foot drilled, is almost certain to be very small.

So much for those parts of Asiatic Russia where oil has actually been discovered. New discoveries and consequent increases in production are probable in all of these areas (except possibly Sakhalin), but the increases over the next 10 or 20 years are not likely to be either very big or very rapid. Distances are enormous, and the effort which has to be put into exploration and development to achieve significant results is very large. However, from a much longer-term point of view—looking ahead 30 or 40 years—the chances of really big oil production in Asiatic Russia are by no means negligible. There appear to be some 3 million square miles of sedimentary cover, much of which must be almost completely unexplored geologically; and it would be surprising if in such an immense region oil were not sooner or later discovered and developed in quality.

Proved Reserves Small

The foregoing has shown that there is no certainty as to what the results of future exploration will be. By far the most important and striking fact is that nowhere east of the Urals have we had, so far, the remotest sign of any really prolific oil accumulations of (for want of a better term) Persian Gulf type. The oil fields which have been found, and the prospects now in the minds of various companies for testing, are all on a relatively very small scale—in many cases on a minute scale in terms of oil to be expected per foot drilled. Such estimates of proved reserves as I have made or collected in connection with this paper, do not, in general, differ sufficiently from De Golyer's estimates to justify separate publication now; and I shall, therefore, merely note that, on De Golyer's most recent figures, the Far East, as here defined, has less than one-fortieth of the world's proved reserves. More than half of the proved reserves of the Far East are in Indonesia, and the next most important countries, on present figures, are British Borneo (whose proved reserves have recently increased appreciably) and Asiatic Russia.

Future for the Far East

We now come to the question of whether production in that part of the earth between the Urals-Persian Gulf and the Americas is likely ever to overtake consumption. The answer, in the short run at least, is almost certainly "no." We have seen that consumption, even at the present almost unbelievably low rates per head, amounts to less than one-twentieth of world consumption; and, it anything is certain, it is that this proportion must increase. I note parenthetically that the distribution of the coal reserves of the world is not such as to invalidate this conclusion. We have seen that proved reserves are only about one-fortieth of the world total; and, on broad general grounds, and thinking of the next 10 or 20 or 30 years, it is hard to see how such small reserves could cope with the increased consumption which we must expect. The same conclusion is reached if, instead of dealing with the Far East as a whole, we consider the main countries of which it is composed. Only a few areas in the East Indian archipelago are likely to have any surpluses over consumption.

How will the deficit be made good? At present the main part of the deficit, except for Russia in Asia, is made good by oil from the Persian Gulf; and a glance at a map of the world, combined with what we know as to America's increasing need for oil. makes it probable that, in the main, this will continue to be the case. In other words, the phenomenally high concentration of oil per square mile in the Persian Gulf area will be used to compensate for the very much lower concentration throughout the huge area which we have been considering.

It is interesting, in conclusion, to consider separately Asiatic Russia plus China. What has been said previously for the Far East as a whole applies equally to Asiatic Russia plus China insofar as proved reserves are concerned. However, we have seen that in both Asiatic Russia and China there are huge sedimentary basins which have not yet been explored. Exploration and development of such large areas will inevitably be slow; but, taking a very long view, it is probable that oil reserves considerably greater than suggested by the present rather small "proved" reserves will eventually be found. It is hard to suggest even a tentative figure for these "speculative" reserves, but it may well be that an assessment of proved reserves in 1990 or 2000 would credit Asiatic Russia plus China with at least 10 per cent of the world's proved reserves, as opposed to (probably) less than ½ per cent today.

A very large part of the additional reserves which I am postulating might be in Russia; and I may perhaps end this short survey with the speculation that, in another 20 or 30 years, when Russian geologists and technologists have been able to bite deeply into the problem of their vast and hitherto largely unexplored Asian territories, Russia may not have the inferiority complex as regards oil reserves which possibly, and perhaps understandably, she now has in relation to the prolific neighboring areas of the Middle East.

I have been asked to say something about the political "climate" in the various countries where there are still chances of obtaining appreciable quantities of new oil, especially from the point of view of American investors. I shall not say anything in this connection about Asiatic Russia and China; and, of the remaining countries, the only ones to which I need refer—under the two quite separate headings of (1) mining rules, etc., and (2) political stability—are Australia, India, Papua, Indonesia, Borneo, Burma, and Pakistan.

Australia, politically stable, offers great security to operators, and the Australian Government has done much to encourage oil exploration. The same applies to Papua; but that country is still in a very undeveloped state, and there are some stringent regulations to protect the indigenous population. British Borneo consists of three separate political units, but all are stable and exploration conditions are reasonable.

The present government of Indonesia, as a single unit (as opposed to a federal system), was formed only last September, and it is too early to say what its policy will be as regards development of its oil.

Burma has been passing through a period of great political unrest; and, although the government has recently reasserted its control in a number of areas, the country as a whole is not yet safe for normal business. The Burmese Government's ultimate objective is nationalization of mineral production; but when this will be enforced is not yet known.

India and Pakistan both have stable administrations, and the greatest threat to security here lies in deep-seated tension — largely religious in origin — between the two countries. The unsettled issue of Kashmir does much to keep this antagonism alive. Both in India and in Pakistan the mining rules are reasonable, and there is no differentiation of any kind as between American and British capital.

All of these countries are, of course, very "oil conscious" and anxious, both for commercial and strategic reasons, to have their own indigenous oil supplies. Not all of them have yet fully appreciated the world-wide significance of the great and rapidly growing Middle East production, or that self-sufficiency in oil must everywhere be the exception rather than the rule. The truth is, of course, that international movement of oil, as of many other commodities, will remain essential to world progress; and there can be few more striking examples of the interdependence of different parts of the globe, or of the benefits which, given real peace, world trade can confer, than the fact that one-half of the human race has such a very small fraction of the world's oil.

Acknowledgment

Gratitude is expressed to the Shell, Anglo-Iranian, Standard-Vacuum, and Caltex oil companies for help in the preparation of this paper.

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Average Completion Cost Is 20 Per Cent Of Total Well Cost

Plan your completion program in the light of improved knowledge of reservoir performance and present-day producing requirements

by T. A. Huber, T. O. Allen, and G. F. Abendroth

DEVELOPMENTS of recent years have pointed more and more toward the significance of well-completion practices in the efficient and economical exploitation of petroleum reserves to obtain high recovery. Of outstanding importance in affecting the general trend of completion practices are: (1) an increased understanding of reservoir and their producing mechanisms, (2) the need for thorough depletion of reservoirs in keeping with good conservation practices, (3) trends toward operations of the unitized type, (4) the higher costs of developing and producing oil and gas reserves, and (5) the over-all demand for and regulation of production.

If the term "completion" is considered to encompass all operations after the top of the productive zone is penetrated, it is estimated that the average completion cost is about 20 per cent of total well cost. With the industry spending over a billion dollars a year to drill and complete wells, it is apparent that several hundred million dollars are spent annually on well completions. A substantial proportion of today's increase over prewar costs results from expenditures made for formation-evaluation services and other completion items, particularly in the development of multireservoir and multizone reserves. A part of this increase is a reflection of the tendency to pyramid similar information services and testing procedures in an intensified effort to locate and define commercially productive reservoirs.

Further costs, ranging from 15 to 25 per cent of the lease and well expense, may be incurred during depletion of a reservoir for subsurface reconditioning work, including mechanical repairs and workovers.

Many well-completion programs are now being planned in the light of improved knowledge of reservoir performance and present-day producing requirements, the emphasis being placed upon satisfactory reservoir drainage and sufficient well capacity with a minimum number of recompletions per well. The realization of these aims is one of degree and requires proper coordination of informational services, completion techniques, and reservoir information, and further attention to development work in completion practices.

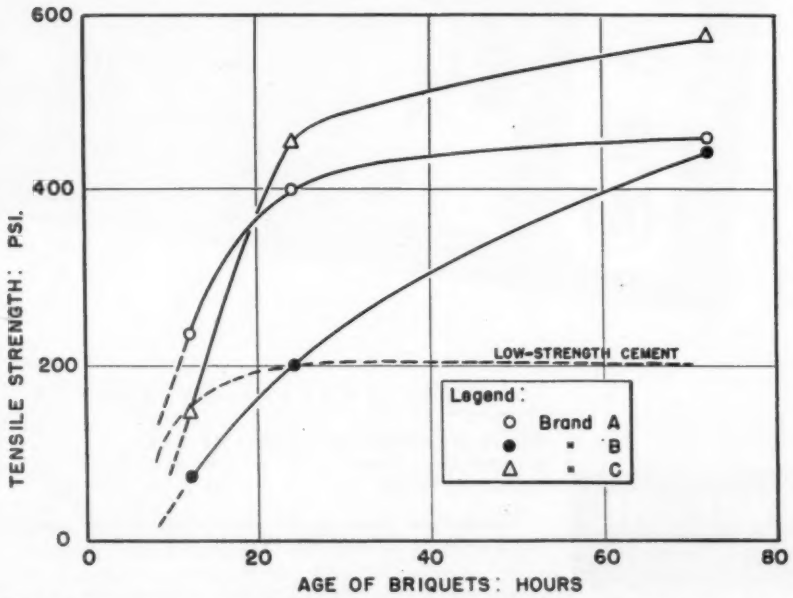

Fig. 1—Comparison of strength development of three conventional slow-set cements and low strength cement cured under water at 175° F.

Reservoir Aspects of Well Completions

Experience has proved that optimum recovery can result from controlling the operation and behavior of a reservoir during its producing life. To exercise such control, it is necessary to initiate well-considered completion practices early in the life of the reservoir and to revise completion practices as dictated by experience and reservoir studies. The selection and location of completion intervals in the various wells is of primary importance in preventing loss of recoverable reserves.

While the first few wells are being drilled, a reservoir-evaluation program is formulated that will provide adequate information for well-completion planning. Included in this information are the limits, characteristics, and content of each reservoir and other useful data such as reservoir pressures and temperatures, productivity factors, and subsurface fluid properties. Study and evaluation of these data, together with a study of area geology and a comparison of the pressure and production history of the early wells with those of older fields in the area that produce from the same horizon, will permit the making of a reasonably accurate estimate of the type of reservoir producing mechanism.

After determining the type of reservoir producing mechanism and the character of the producing formation, completion intervals are located to take advantage of available reservoir energy and to obtain high recovery. Where possible, the completion intervals for various wells may be selected to permit simultaneous depletion of the various members of the reservoir.

In water and gas-cap-drive reservoirs, the operator's principal control over water and gas production is that of selecting the proper completion interval for the individual wells, both on the initial completion and the recompletions necessitated by gas-cap expansion or water invasion. Careful planning is necessary to provide a completion program that avoids trap-

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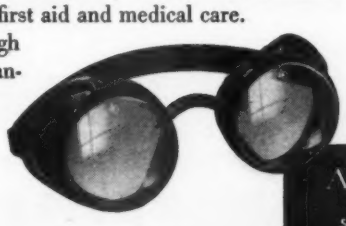

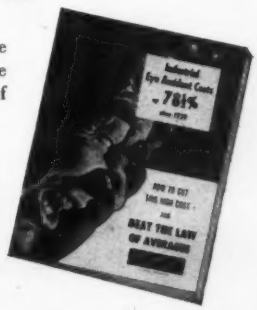

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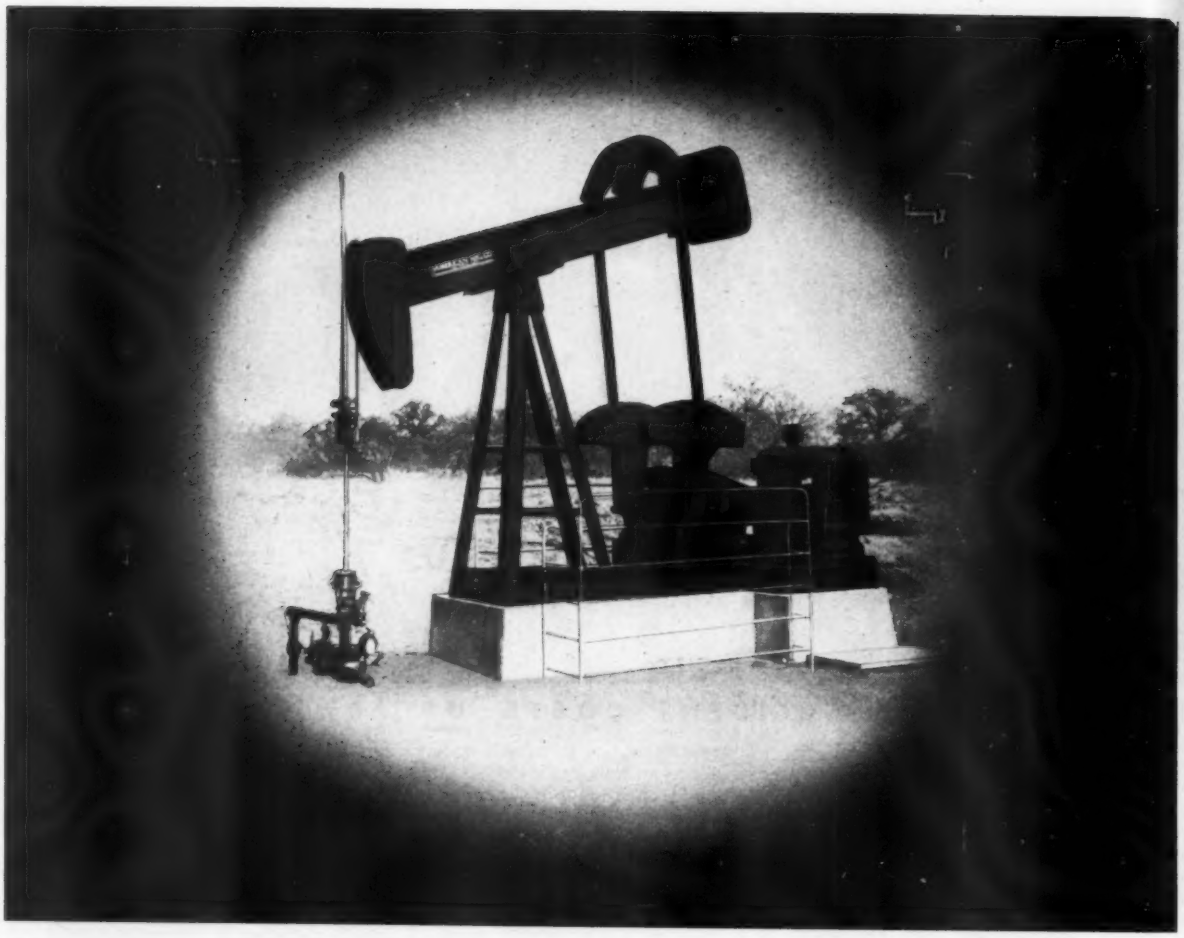

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ping or isolation of oil and unnecessary recompletions.

Completion intervals are limited in multizone reservoirs having interbedded barriers to vertical permeability so as to provide control of drainage and secure maximum recovery, but are adequate at anticipated producing rates to prevent excessive pressure drawdown around the well bore and attendant coning and fingering of gas or water. Where undesirable quantities of gas or water are produced because of poor completion practices or thin zone conditions, it is frequently necessary to limit the reservoir production rate to that required for efficient performance of the individual wells. Thus, the rate of return of an operator's investment in the development of a field can be critically affected by reservoir conditions and completion practices.

Well-Completion Techniques

During the past few years, a number of notable developments have occurred in completion techniques. The following summary reviews some of the chief developments in the major phases of well completion, but does not attempt to list all of the many fine developments.

Cementing.—Deeper drilling, with its increasing pressure and temperature conditions, has necessitated the development of oil-well cements that are tailored to perform satisfactorily at the greater depths. These cements have generally shown greater ultimate strength, which is of questionable value in oil wells and increases the gun-perforating problem.

Use of casing scratchers and centralizers to improve the bond between cement and formation has reduced the percentage of primary cement-job failures and has correspondingly raised the requirements on gun-perforator penetrating ability. Surface tests of gun perforators have shown that as the cement strength is increased, the depth of perforator penetration is reduced and the extent of cement cracking is increased.

It has been suggested that wells be perforated after only partial setting of cement in order to reduce cracking and to increase perforator penetration.[1] Since the rate of strength

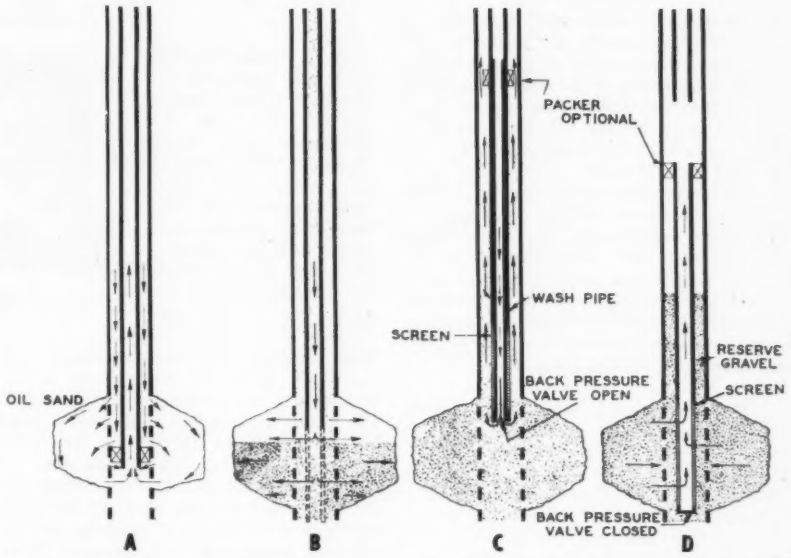

Fig. 2—(A) Washing perforations to remove sand for space to place gravel. (B) Gravel being squeezed through perforations. (C) Cavity filled and screen being washed through gravel. (D) Gravel and screen in place. Wash pipe removed and well producing.

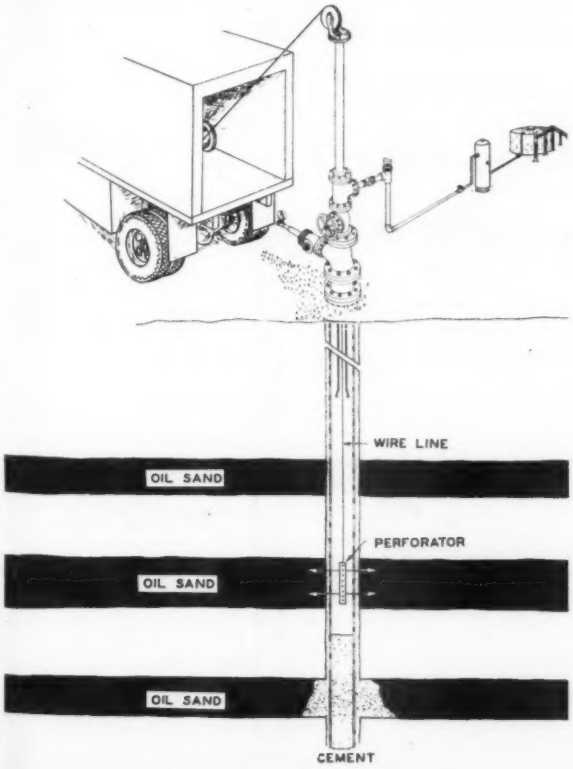

Fig. 3—Perforating for original completion.

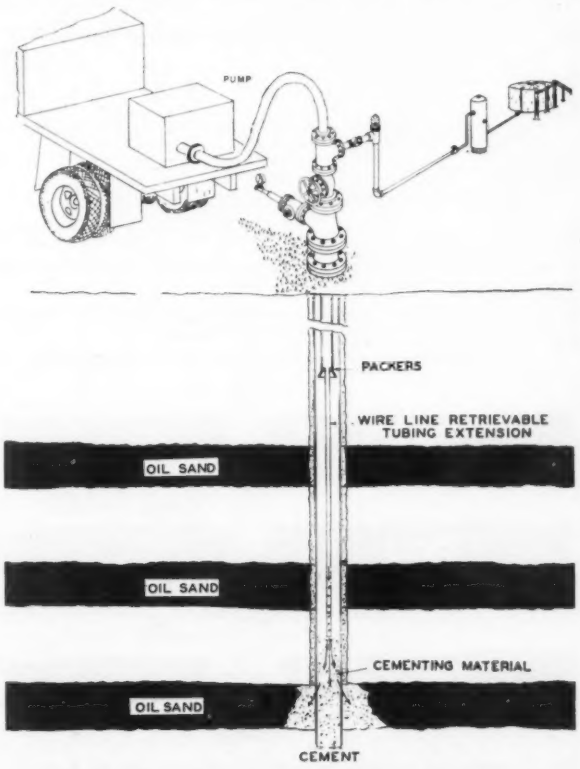

Fig. 4—Squeezing cementing material for recompletion.

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development varies with the type of cement, the slurry composition, the elapsed setting time, and the bottom-hole conditions, it has been difficult to establish field procedures that would account for all the variables and result in perforating each well at the correct time.

The proposal to perforate at the time of optimum cement strength also gave no solution to the problem of perforating old wells during workovers where the cement had already reached its ultimate strength. To meet these problems, new modified cement compositions having low, controlled ultimate strengths have been developed.

One type of modified low-strength cement is prepared with normal portland or high, early-strength cement, bentonitic clay, a dispersing agent, and a high water-to-cement ratio. The properties of the set cement are sensitive to the uniformity of the mix and to the relative portions of the various components.

A cement of approximately 200 psi. ultimate tensile strength can be obtained by mixing 12 to 15 lb. of bentonitic clay, 0.5 lb. of calcium lignosulfonate, and 9 gal. of water with a sack of normal portland cement. High early-strength cement may be substituted for normal portland cement if the water content is increased from 9 to 10 gal. per sack. A comparison of the strength development of this modified cement with several brands of neat cement is shown in Fig. 1.

The modified cements have four advantages which make them desirable for use in oil wells:

1. Their low ultimate tensile strength of about 200 psi. allows substantially greater penetration by perforating guns than is obtained when using normal neat cement which has an ultimate tensile strength of 500 to 700 psi.

2. Their lower tensile strength results in localized cracks around the shot perforations, as compared with long radial cracks of possibly as much as 18 in. in hard cements.

3. It has a greater slurry stability than conventional cement mixtures, which reduces the possibility of hav-

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This paper was presented at the A.P.I. thirtieth annual meeting in Los Angeles, November 9-17.

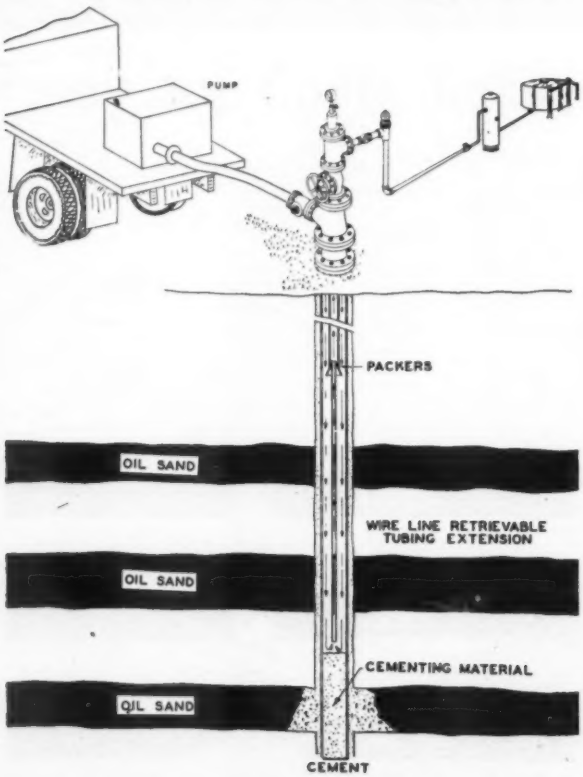

Fig. 5—Reversing excess cementing material out of hole for recompletion.

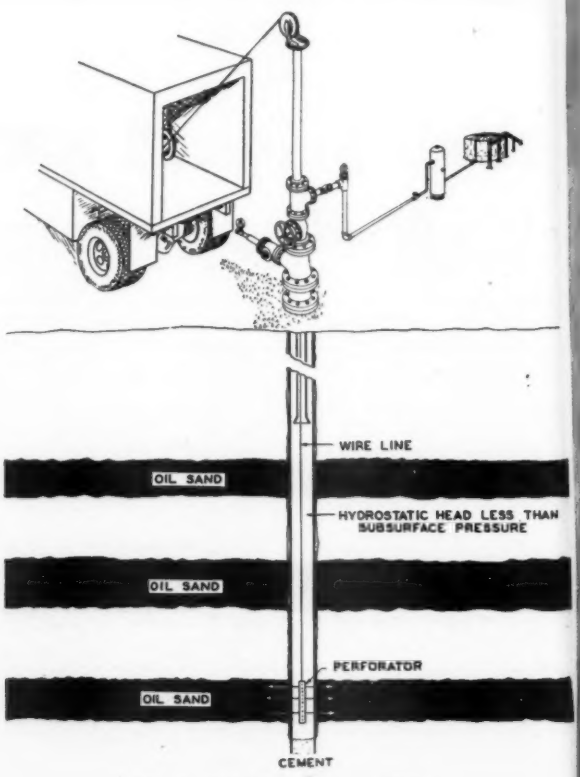

Fig. 6—Perforating for recompletion.

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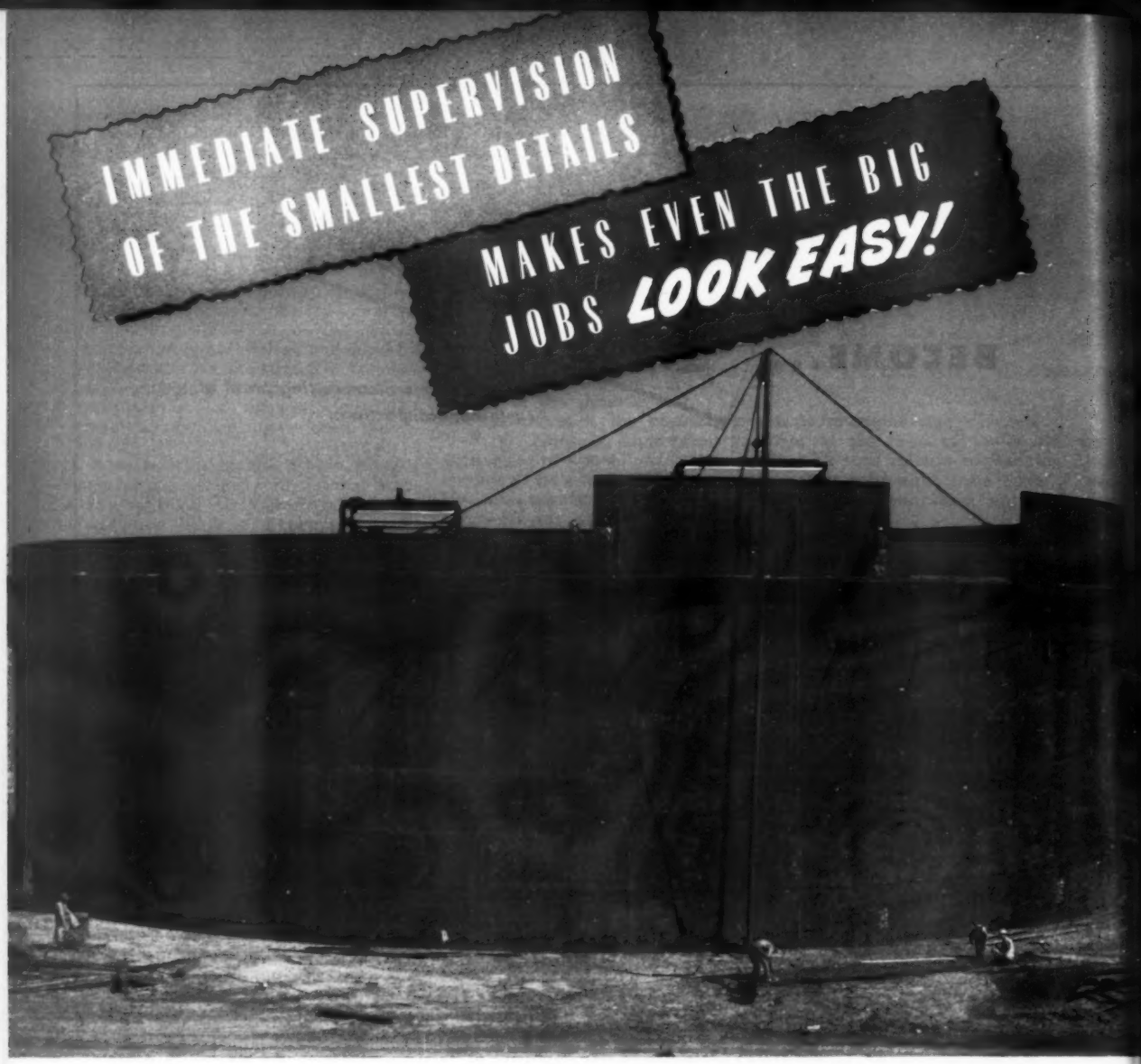

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ing an uncemented section created by separation of the water and cement before the slurry has set.

4. It has a slurry density as low as 12.5 lb. per gallon as compared with 13.8 lb. per gallon for 4 per cent gel cement and 16.0 lb. per gallon for neat cement. This lower density permits the placement of longer cement columns without exceeding formation breakdown pressures.

Field trials of modified cement by one operator have proved it to be satisfactory for both primary cementing jobs and workovers. In 5,300-ft. wells of Coke and Runnels counties, Texas, the light modified cement is being used in a single stage to obtain a long cement column and protect the oil-string casing from a corrosive interval in the upper formations, thus eliminating the necessity for stage cementing. In these wells, a cellophane sealing agent is employed to prevent cement loss to the formation and the required fillup behind the casing has been obtained on 29 of the first 30 jobs. In these wells, single-stage cementing with modified cement effects a saving equivalent to 40 per cent of the complete cementing operation cost of two-stage jobs. A portion of this saving results from the 15 to 20 per cent lower material cost per cubic foot of modified cement slurry as compared with the cost of either 4 per cent bentonitic or neat-cement slurries.

Modified Cement in Workovers

Modified cement has also been successfully employed in workovers to reduce gas-oil ratios when it was used to cement long liners in Means field, Texas. Previous workover jobs of this type had been unsuccessful, apparently because of failure to obtain a bond and because of the difficult perforating problem created by neat cement.

On a number of other field tests made in Texas and Louisiana, modified cement was employed to combat lost returns, to provide an easier perforating problem, and to seal off water or gas. Satisfactory production rates and apparently satisfactory settings were obtained in all cases except one, which failed due to nonuniform mixing of the dry components. However, general field use of modified cement has been somewhat impeded by the requirement for close control of the mixing of the dry components.

The modified cement referred to above is only one example of the general trend toward lighter-weight cements. Low-density cements are being prepared with 2 to 6 per cent bentonite, and with a combination of bentonite and expanded pearlite. These cements also find application where formations will not support an equivalent column of heavier neat cement. Some operators meet the problem of placing long cement columns by stage cementing and improvements in multistage cementing tools

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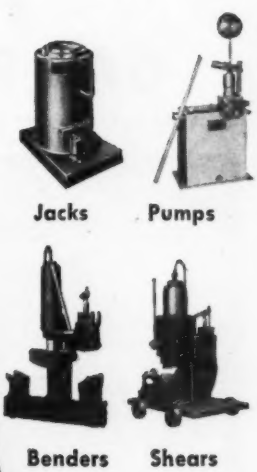

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have increased the success attained by this technique.

Another recently adopted practice of significance is the use of both bottom and top plugs while placing cement.[2] The addition of the bottom plug has proved beneficial in cleaning the pipe, in reducing contamination, and in improving the primary casing-cement jobs.

Gun perforating.—The completion of oil and gas wells through gun perforated casing is widely practiced by the industry at the present time because of the control of the producing zones that is afforded. However, there has often been considerable question as to the number of such perforations actually open to the producing formation, particularly when a sizable number of perforator bullets are bailed from the well after perforating and when the productivity of the perforated well is appreciably lower than indicated on previous open-hole drill-stem tests.

Penetration difficulties have been experienced especially where necessary to perforate two or more strings of casing or to perforate sections of casing which have been previously squeeze cemented. These field observations, along with new developments in perforating guns, have stimulated interest in the present status of gun perforating oil and gas wells.

Deep penetration is always desirable in perforating an oil or gas well to insure that formation pore space adjacent to the well bore is in communication with the interior of the well casing and to provide adequate producing capacity. To reach the relatively uncontaminated portion of the producing formation, it is usually necessary to penetrate successively at least ¼ to ½ in. of steel casing, 1 to 3 in. of hard cement, and ¼ to ½ in. of mud cake and contaminated formation, or a total of 1½ to 4 in. of steel, cement, and formation. If the zone has been squeeze cemented or if the hole has become enlarged while drilling, an even more severe perforating problem is presented.

In 1946, Oliphant and Farris reported that the penetration obtained on their experiments with bullet type perforators ranged between zero and 2½ in. when perforating one string of casing surrounded by a sheath of hard cement.[1] Recent perforating experiments by oil operators, performed under simulated well conditions and with guns normally by Oliphant and Farris.

May Produce Through Cracks

Since bullet perforations are accompanied by considerable cement cracking, it is apparent from the above data that many wells may produce through cracks in the cement rather than directly through intended perforations in the cement. A majority of the perforators available for perforating oil wells in 1946, and possibly as late as 1948, probably did not have sufficient penetrating power to assure penetration consistently into formations.

The adaptation of the shaped charge to oil-well perforating stimulated interest in perforator penetrating ability and resulted in development of improved bullet perforators as well as jet perforators between 1948 and 1950. These new perforators have been in the development stage during the past 2 years and they are not yet readily available in all areas. Some of these more powerful guns have been offered at premium prices.

Bullet perforators produce relatively smooth, round holes and the perforations are usually between ⅜ and ½ in. in diameter, depending on the bore of the barrel. This uniform hole extends through the steel casing, cement, and formation to the maximum depth of penetration where the hole is probably plugged back for the length of the bullet. Most of the bullet perforators now commercially available produce burrs on the inside of the casing, even though no-burr devices are employed.

Bullet shot holes that penetrate hard cement are normally surrounded by radial cracks in the cement, possibly as a result of the splitting action of the bullet mass moving through the target material. The cracks range from localized hair-line cracks in low-tensile-strength cements to more extensive cracks and shattering of the

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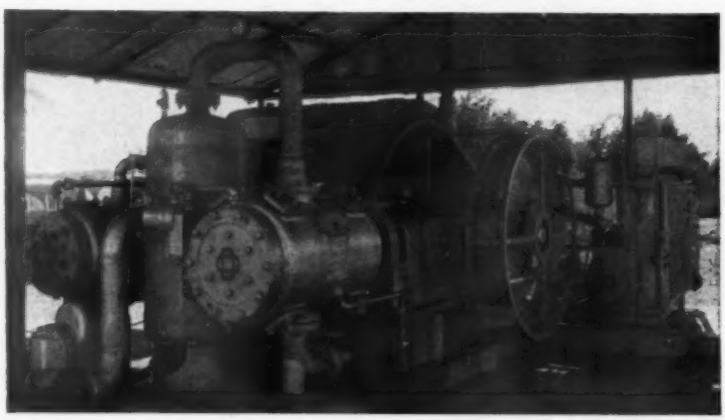

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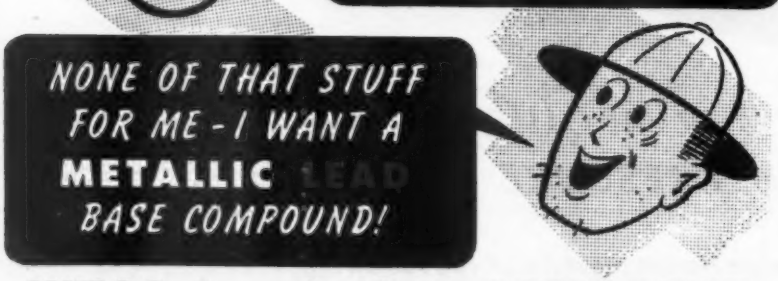

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cement adjacent to the shot hole in hard, high-tensile-strength cements.

Jet-perforated holes are somewhat rough and more irregular than bullet holes. The hole diameter in the casing is about 9/32 in. for guns used in 5½-in. o.d. casing; and the shot holes are slightly conical, becoming smaller in the direction of penetration. Residue of the charge liner, called a carrot or slug, may be lodged in the shot hole and may cause partial or complete plugging of the hole. Inside casing burrs resulting from jet perforating are considerably less severe than burrs produced by most bullet perforators.

In many areas, there is about equal preference for bullets and jets; however, for special types of jobs, the following preferences appear to prevail. Bullet perforators are preferred where:

1. Cracking of cement is desired to increase drainage area.
2. A low-tensile-strength cement is used, because of the resulting larger and more uniform holes.
3. Because of the lower cost of the service, particularly where the perforating problem is not believed to be difficult.
4. It is desired to perforate several selected short intervals, since most bullet perforators may be selectively fired.

Jet perforators are preferred when:

1. A difficult penetration problem is believed to exist, such as where the interval has been previously squeeze cemented, where multiple strings of casing are to be perforated, or where it is suspected that an abnormally thick sheath of cement is present around the casing.
2. It is necessary to perforate near a gas-oil or oil-water contact, since shaped-charge perforating produces only localized hair-line cracking in cement.
3. In deeper wells where the anticipated temperature is in the order of 250° F. of more, because of the greater temperature stability of the explosive.

In the bullet perforating field, several new gun designs have been introduced recently for field testing. Greater penetration and less inside casing burr are the primary advantages claimed for these guns. Emphasis in jet perforators is presently centered on debris-free guns for field service. Laboratory experiments are in progress to improve the efficiency of the shaped charges and to increase gun life.

Formation fracturing. — Significant developments have occurred recently in the technique of increasing well productivities by hydraulic formation fracturing processes. If fluid is injected into a formation at high rates and pressure and if the pressure suddenly drops appreciably while injecting at the high rates, this phenomenon is commonly termed "formation breakdown" and is believed

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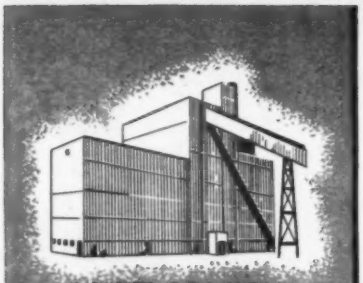

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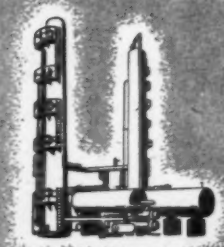

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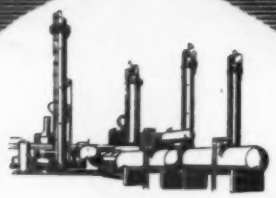

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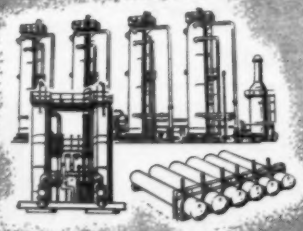

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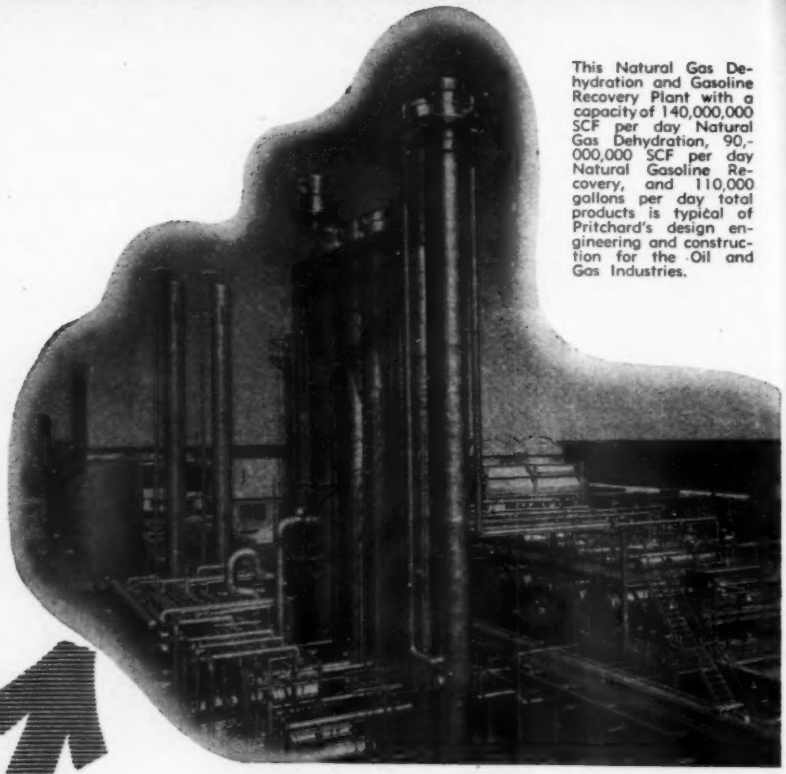

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to result from fluid fracturing. In cases where the fluid pressure is in contact with the cement sheath around the casing, the fracture may be in either the cement or the formation.

Formation breakdown has long been experienced when pumping into wells, principally during acidizing and cementing operations. Increases in production after squeezing acid, oil, water, or mud into a producing zone are common in the experience of many oil operators. Recent attention to this source of potential production increases has centered around the development of a low-cost technique for fracturing that could be applied where conventional methods of stimulating production, such as acidizing, reperforating, and nitroglycerin shooting, would be inadequate or would have accompanying objectionable features.

Hydraulic formation fracturing appears to be applicable and advantageous in the case of hard, low-permeability reservoirs because it is frequently difficult to operate such reservoirs profitably for a sufficient length of time to obtain high ultimate recoveries. Experience in pumping various fluids into wells suggests that hydraulically created fractures may, in some cases, extend to adjacent wells at distances of more than 1,000 ft. Maximum benefit from fracturing is gained in some wells by isolating a portion of the zone for treatment or by performing several successive fractures.

To fracture a zone through perforated casing, it is necessary to have the cement behind the casing in good condition to prevent bursting the pipe or breaking down the cement with the high pressure employed. No special treatment is required for the well either before or after fracturing, except that swabbing is preferred for removing the injected fluid prior to normal production by flow or artificial lift. Fracturing is not generally recommended for formation intervals near gas-oil or oil-water contacts as there is a probability of creating vertical fractures which may provide flow channels for undesired water or free gas production.

Success in increasing production has been reported recently in California and Wyoming, when stock-tank crude was squeezed at high rates and pressures. More limited success has been obtained in Texas by this technique, and one of the difficulties experienced is the high-pressure loss developed when low-viscosity crude is pumped through tubing at high rates. To achieve the pressures required for fracturing, some operators are experimenting with higher-viscosity crudes.

One of the more widely used hydraulic fracturing techniques has been made available to operators through a service company.[8] This process comprises: (1) the injection of a gelled high-viscosity fluid into the formation under pressure in an effort to create and extend a fracture, (2) an attempt to prop the fracture open with granular material, such as sand, which is suspended in the fluid or gel, (3) pumping a gel breaker into the formation to reduce the viscosity of the fracturing fluid, and (4) swabbing the well to recover the injected materials. Gel fluids have been prepared with Napalm soap and either gasoline, kerosine, or stock-tank crudes. Ottawa sand has been generally used as the propping agent, and the gel breaker is supplied by the service company.

Approximately 1,400 commercial treatments with the foregoing process are reported to have been made during the past 2 years. Data obtained from the service company purports to show that production was increased in over 75 per cent of these wells. The North Central Texas-Oklahoma-Rocky Mountain area accounted for the major portion of this work and also for the majority of the successful jobs, although this process has been applied in almost every oil-producing area in the United States.

A possible disadvantage of hydraulic fracturing lies in the difficulty that may be encountered in controlling

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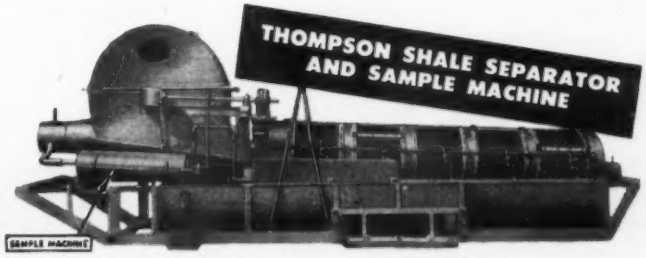

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secondary recovery operations if fractures have been created that extend long distances from the well bore and are conducive to channeling of the injected fluids.

Sand Exclusion

The problem of excluding sands from well bores is complex and it appears that no one method of sand exclusion can be universally successful because of variations in sands in well and reservoir conditions, and in required producing rates. Sand may be controlled by one or a combination of three general methods: (1) manipulation of producing rates, (2) use of screening materials, and (3) use of consolidating plastics. Whether conventional screens and liners, bonded filters, consolidating plastics, or gravel packs are used, cleanliness of the sand face during completion operations is essential for satisfactory well potentials.

Fluid - rate manipulation. — Well-producing rates have been manipulated to handle sand problems by: (1) flowing at such a low rate as to avoid the movement of sand into the well bore, and (2) flowing temporarily at a high rate to cause the formation of a large-diameter cavity such that at normal producing rates the fluid velocity at the periphery is insufficient to cause sand movement. The first of these is frequently impractical because of the extremely low flow rates required to avoid moving very fine sand, and the second is considered unwise because (1) it may result in premature production of salt water or gas-cap gas and (2) because it creates a hole condition that makes remedial work for gas or water control difficult.

Mechanical screens and filters. — While conventional slotted pipe and wire-wrapped screens have been used for many years, the value of screens in actually excluding sand is questionable in many cases. Where severe sand troubles have arisen, the slotted pipe and wire-wrapped screens are usually ruled out because they have been found incapable of screening extremely fine, unconsolidated sand. However, in areas where support of the formation is necessary instead of screening, conventional screens may have considerable merit. Liners prepacked with gravel are partially successful in controlling sand, but are susceptible to plugging.

There are a number of highly permeable bonded filters available for use in controlling sand production, but their main disadvantage is that they will plug with colloidal mud particles or filter cake from the sand face. Also, some filters are fragile and often break during completion operations. Sintered metal has been tried experimentally but has also encountered plugging difficulties.

In California, sand production is being controlled by the use of conventional slotted liners or prepacked

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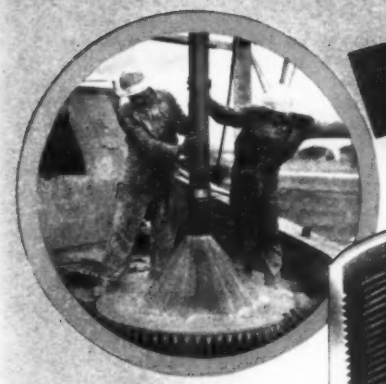

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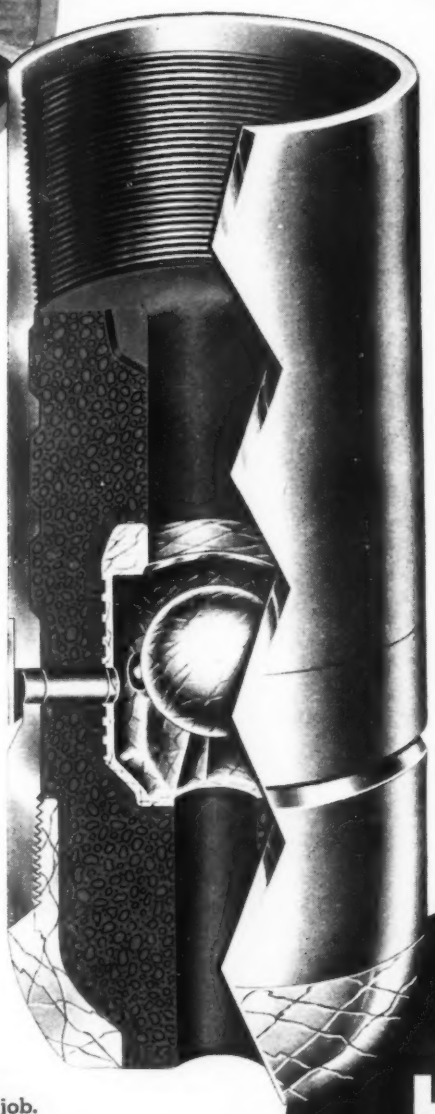

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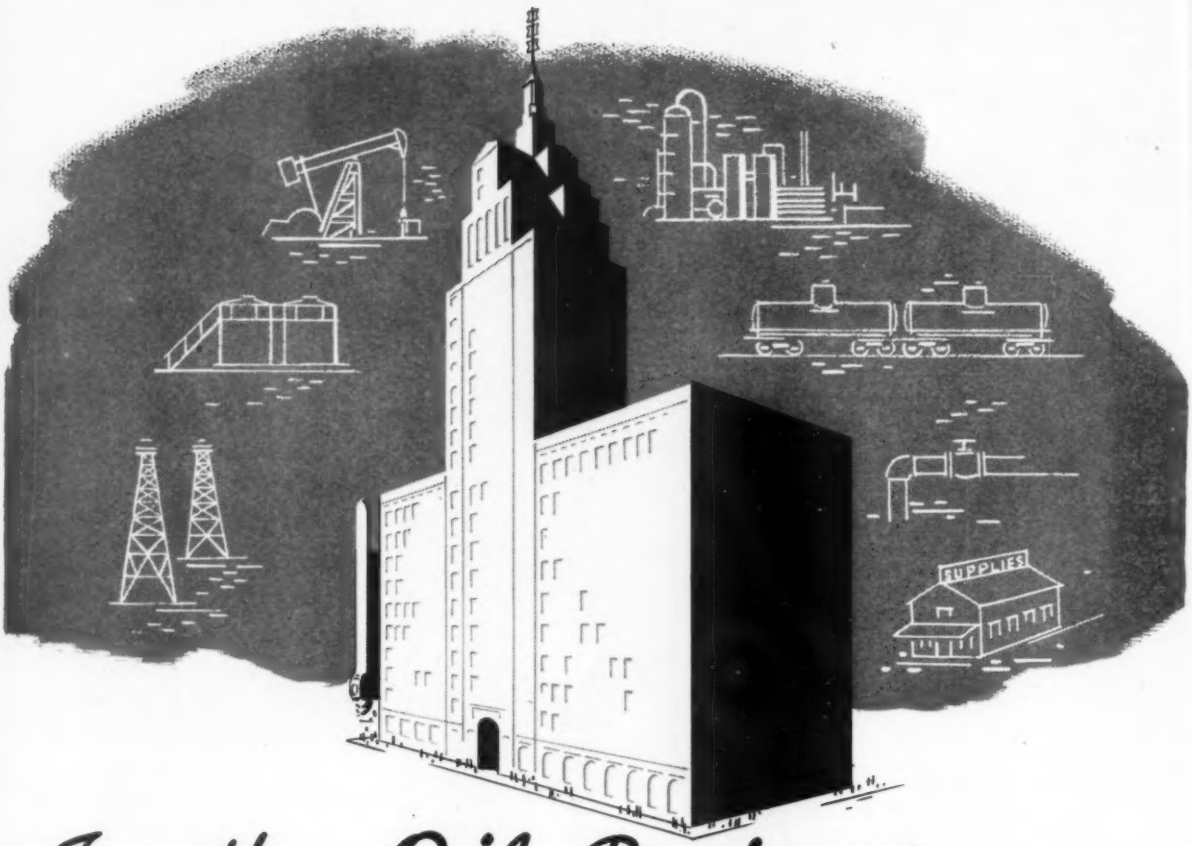

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gravel liners which are usually set in open hole, or by packing the open hole with gravel which is circulated in place around the liner.[4] Liner slots and gravel size for the coarse sands are larger than currently used in the Gulf Coast area. The chief problem appears to lie in the plugging of the gravel or slotted liner and the handling of viscous fluids. When the plugging of the gravel or liner becomes excessive, the pack or liner is usually washed with fluids such as light oils, hot oils, water-base chemicals, and heat generating chemicals.

Gravel-pack screening.—There has been considerable controversy concerning the maximum size gravel that will retain a given sand, and a large percentage of gravel pack failures are believed to have resulted from errors in attempting to use this maximum. However, both theory and field experience indicate the use of smaller gravel has no appreciable direct effect on producing potential. Therefore, the proper size gravel for any sand is believed to be the smallest gravel that will not be plugged by the fluid medium used in completion and which will still be large enough that the individual gravel grains will not pass through their retaining screen.

The size gravel that fulfills the above requirements will range from 0.02 to 0.06 in. in diameter and should be graded with the maximum diameter not more than 50 per cent greater than the minimum. These gravel sizes will pass a sand-free liquid suspension of commercial clay. However, during completion operations, filter cakes may form on the sand face and a large portion of this compacted mud cake cannot flow back through the gravel pack, resulting in decreased well potential. Also, the amount of gravel that can be placed in a well is greatly diminished by the filter cake because the carrying fluid cannot be squeezed into the formation.

Clean oil or salt water will not plug the sand face and they can be used to advantage as carrying media for the gravel. Either of these fluids can be used to wash producing perforations, to remove sand, and to place gravel outside the casing. Clean oil or salt water can also be used in gravel packing open hole if all of the gravel is placed in one stage and the screen and liner are washed to bottom through the gravel.

A number of methods of gravel packing wells have proved to be generally satisfactory recently. The simplest and most successful method is discussed in the following summary. The perforations are washed with a special wash tool by reverse circulation, using a clean fluid medium as shown in Fig. 2-A, unless sufficient sand has been produced from the well to provide adequate space for the gravel. Open-ended tubing or drill pipe is then run and a small batch of gravel is circulated to bottom by normal circulation. The blowout preventer is then closed and the gravel is washed through the producing perforations by squeezing fluid into the formation, as illustrated in Fig. 2-B.

The drill pipe or tubing string is worked up and down through the perforated interval during this operation in order to facilitate the movement of gravel out through the perforations. These operations are repeated until the space behind the casing is filled with gravel and the desired amount of reserve gravel is placed inside the casing. A screen and liner is then run and washed down through the gravel to the desired depth, as shown in Fig. 2-C. The assembly is released, the wash pipe is pulled, and tubing is run to prepare the well for production, as shown in Fig. 2-D. The use of the liner packer on top of the assembly is optional as it appears that a seal at this point is not essential. Operations for gravel packing open-hole completions are similar to those for perforated completions, except that enlargement of the hole to provide space for the gravel is accomplished by underreaming.

This procedure has proved effective in controlling sand production, and it is believed that the high percentage of successful packs in the Gulf Coast area is largely attributable to: (1) the use of clean fluid, thus eliminating plugging by drilling mud; (2) the use of finer gravel than that previously used or theoretically re-

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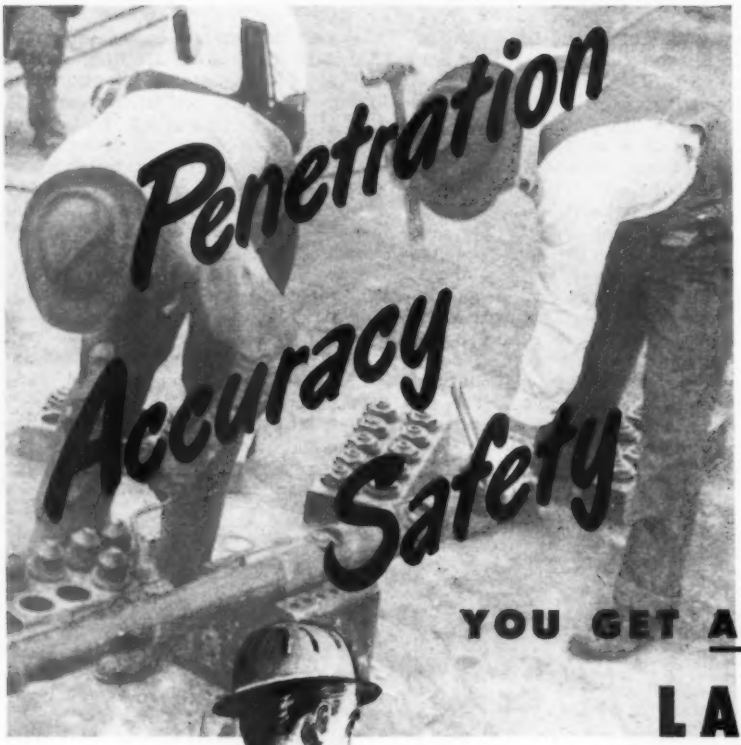

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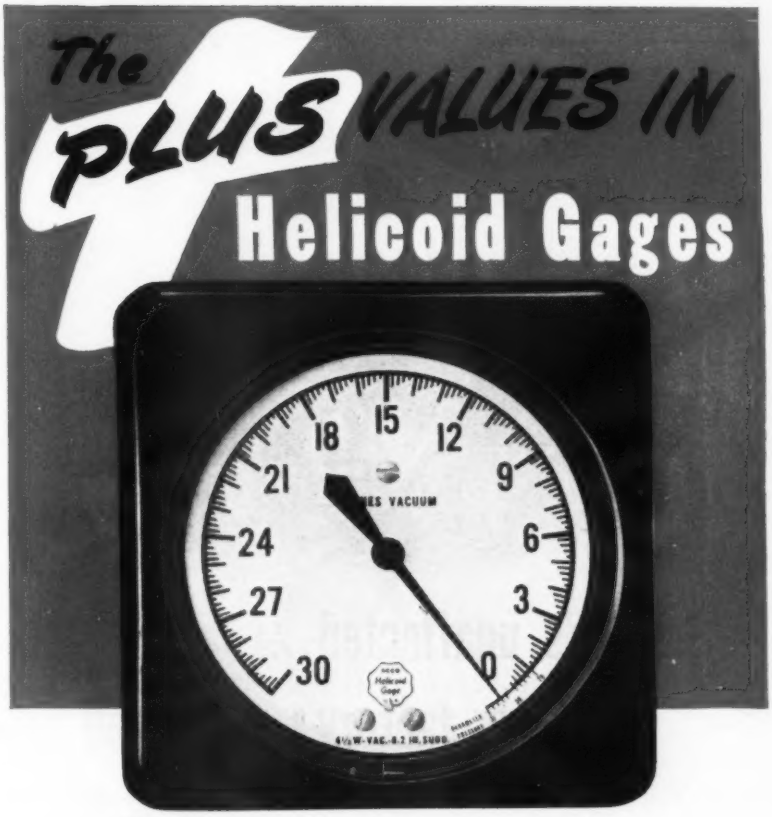
quired by sieve analyses; (3) the placing of all of the gravel in one stage and washing the screen and liner down through the pack which decreases the possibility of the pack becoming contaminated with formation sand and shale and simplifies the entire operation of gravel packing.

Consolidating plastics.—Sand consolidation, utilizing thermosetting resins or plastics to cement the sand grains in place and at the same time to retain sufficient permeability for production, has been applied to producing wells and a promising degree of success has been achieved particularly in South Louisiana. Unconsolidated sands can be successfully consolidated in the laboratory with such plastics, but under actual field conditions difficult-to-explain failures have occurred. It is believed that a high percentage of the field failures are the result of improved placement techniques. It has been found that multistage treatment of producing intervals 2 to 5 ft. long has been more successful than treatment of intervals over 5 ft. Sand consolidating plastics are available from several service companies and, while plastics have been used for a number of years, their application continues to be very limited.

Depth Measurements

The importance of obtaining accurate depth measurements has been widely recognized, and measurement correlations continue to receive the attention of both operators and service companies, particularly in deep wells and where completion intervals are critical. As before, the basic yardstick of depth measurement during drilling operations and attendant activities such as coring, drill-stem testing, and running casing continues to be tubular-goods measurements.[5] These tubular-goods measurements must subsequently be correlated with the wire-line measurements involved in electric and radioactive logging, side-wall coring, gun perforating, and other wire-line operations.

Considerable effort has been expended to increase the accuracy of wire-line measurements by such means as improved cable design, the use of factory-stretched cables, and more careful calibration procedures. In many instances, excellent correlation between drill pipe and electric-log measurements has thus been obtained. Nevertheless, it is sometimes difficult to reconcile measurements made by different methods and to definitely relate gun-perforating operations with possible productive formations. This problem is of particular importance in deep wells with multiple producing horizons and thin pay sections where the accuracy of measurement is critical if the perforations are to be properly located with respect to the gas-oil and oil-water contacts, or in some instances if they are



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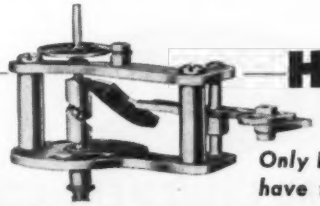

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even to penetrate the desired producing zone.

During recent years, there has been a strong trend toward correlation of formation depths with the wire-line operations involved in well completion through the use of collar locators. The usual procedure is to run a combination gamma-ray and collar-locator survey by which the formation tops and bottoms as identified on the radioactivity log are referred to the casing collars. Subsequent wire-line operations such as gun perforating, setting bridge plugs, and setting packers are again referred to the casing collars through the use of collar locator devices and positive positioning is secured with respect to the intervals selected on the gamma-ray log. Initial difficulties in the use of this method by reason of uncertainties in electrical log-gamma ray log correlation are being resolved through increasing use of radioactive logs and the development of more familiarity in their interpretation. Alternative procedures such as correlating neutron logs with the electrical resistivity curves are also being studied, particularly where gamma ray and self-potential logs do not correlate satisfactorily.

In low-radioactivity formations, such as the sandy shale formations of the Gulf Coast, electrical log-gamma ray log correlation is apt to be poor. In such formations, an open-hole gamma ray-self potential log combination is sometimes run. After pipe is set, a second gamma-ray log is run in conjunction with collar locators. Since the first gamma ray is tied to the self-potential curve, the correlation will permit the tying in of casing collars to electric-log depths.

Information Services for Formation Evaluation

Formation evaluation is necessary in well completion practices to provide data which aid in (1) locating zones that are worthy of the expensive completion attempt, and (2) indicating fluid content and contacts within such zones so that the best choice of completion interval can be made. Principal services available for this evaluation include well logging, coring and core analyses, and drill-stem testing. A trend exists toward improved analysis of electrical well-logging data in areas where it can be utilized, with the view to minimizing coring, core analyses, and drill-stem testing.

Well logging.—Well-logging services include electrical, radioactivity, and formation cuttings mud analysis well logging. Each has a particular place in well completion. The electrical well log is given preference in relatively soft sand-shale formations. Much emphasis is being given to electrical logging by the operating companies, as is evidenced by the technical staffs they maintain for the interpretation, the investigation of log-

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ging techniques, and for research into the use of electrical log data for quantitative determination of fluid content and formation porosity.

In some areas, amplified resistivity curves are being used to study shale sections for the purpose of detecting faults and formation changes within those sections. This technique aids in detecting formation structures which may not be apparent by use of other methods.

During the past 2 years, a new logging technique has come into prominence in the industry. Through measurement of the resistivity of microvolumes of material on the wall of the bore hole by closely spaced contact resistance electrodes, the method is claimed to be capable of differentiating permeable and impermeable zones.

The new type log is generally being used as a complement to the standard electrical well log, especially in hard formations where information from the standard log has been somewhat limited. In soft formations, this new type log has not been used appreciably, but it may later provide a supplement which will allow better determination of net pay thickness in soft formations. Knowing the exact depth location of permeable and impermeable zones within a formation section permits better selection of completion and recompletion intervals. More field testing must be done to prove the general reliability of this new logging technique.

Radioactivity well logging is being used to a considerable extent for evaluation of hard formations and location of possible productive zones back of casing in old wells that were not logged during original completion, in addition to its important use in well depth-measurement correlation work, which has previously been discussed. During the past year, much field work has been done to determine the utility of neutron-curve data for use in making quantitative estimates of porosity in certain hard-rock formations such as the Pennsylvanian reefs and pre-Permian beds of the Permian basin areas. When a correlation between neutron curve deflection and porosity can be established for a zone in a field, porosity values of the zone in other logged wells can be obtained without core analyses by use of the established correlation and the neutron curve. While this work is in much too early a state of development for final evaluation, it has given very encouraging results in some areas.

A radioactivity well logger, which is able to obtain a gamma-ray curve and a neutron curve simultaneously, and thereby has the potential of reducing radioactivity logging time by 50 per cent, was made available to the industry during the past year. This logging procedure needs to be proved further through usage. Since introduction of this logger, work has been started to revise conventional radioactivity well-logging equipment to allow faster and possibly simultaneous logging as well.

By use of trailer laboratories that are set up on the job, formation cuttings and mud-analysis well logging usually provide, during drilling, a 24-hour per day indication of the presence or absence of hydrocarbons in the formation cuttings and mud that are pumped from the well. This logging method ordinarily cannot indicate the quality of a hydrocarbon show, but will usually indicate its presence. The method is being used increasingly on wildcat and field wildcat wells to aid in the formulation of testing and coring programs.

Coring and core analyses.—Core analyses and description of cores are continuing to be used to provide basic information concerning formation characteristics. These data, in addition to their use in completions, usually are the basis from which the validity of data from a logging service is determined. Diamond coring has made it feasible, from the standpoint of both recoveries and economics, to obtain cores of hard, abrasive, and cherty formations.

Because limestone formations may contain several types of porosity within one particular zone, the trend has been toward use of larger portions of the core sample, up to 18-in. pieces, than are used in conventional plug

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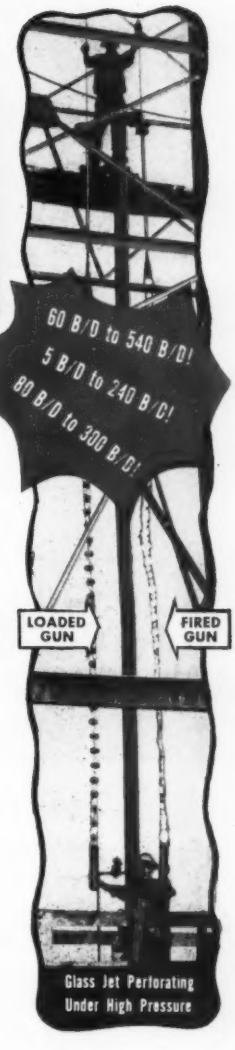

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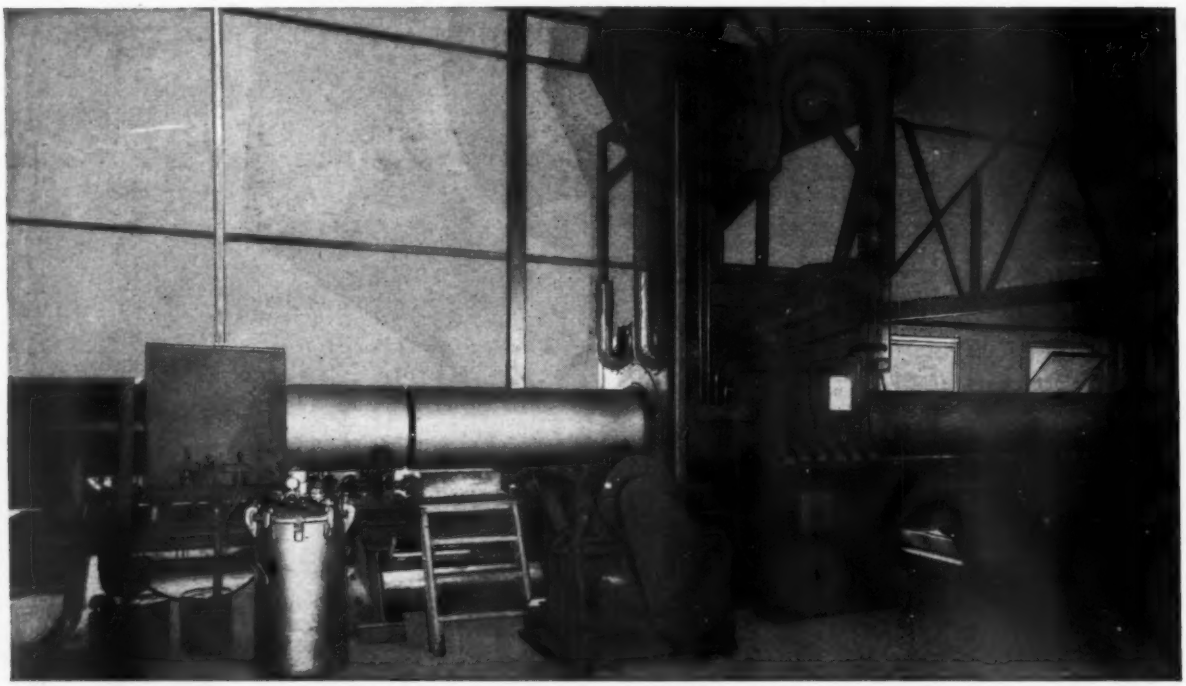

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analyses in order to obtain porosity and permeability values that are more representative of actual formation condition. When accurate data concerning the percentage and nature of formation water in cores are desired, oil-base muds have been used instead of the usual water-base mud.

Side-wall coring tools are being developed to recover larger-diameter cores, with the view of providing more material for inspection and analyses and so as to obtain more representative formation data. While some trend is apparent toward obtaining quantitative data from side-wall cores, enough comparisons with regular cores of the same zone have not been published to indicate the reliability of side-wall core quantitative information.

Multiple (Dual) Reservoir Completions

A number of multiple-reservoir completions were made during World War II under conditions of high crude demand and critical shortages of tubular goods. In 1946 and 1947, the trend toward dual completions was reversed as operators found through experience the many difficulties and problems which beset such wells. A survey at that time indicated an attitude that the dual completion has no operating advantage over a single completion, and that all of its advantages are related to the cheaper initial development cost.

Since 1947, several items of equipment have been developed or improved to meet dual-completion problems. Retainer-type packers can now be set by wire line, which reduces rig time. Crossover packers and accessories have been improved. Several types of dual-pumping equipment are being marketed and field tested and the crossover principle has been incorporated into gas-lift equipment.

Equipment improvements and the high cost of drilling today have exerted pressure on the operators to return to wider acceptance of dual completions as a means of possibly cheaper exploitation of multireservoir fields. While a certain number of dual completions are made each year, and such completions are found to be economical in some cases, most operators prefer to give serious and detailed consideration to the long-time effect of such completions on reservoir operating efficiency and producing costs before embarking on a large-scale program of dual completions in any specific field.

Techniques and equipment utilized in dual completions have not reached the stage of development to permit their ready acceptance by the majority of operators as normally satisfactory. The risk involved by failure of a very small percentage of dual completion settings can be enormous.

From the foregoing discussion, it

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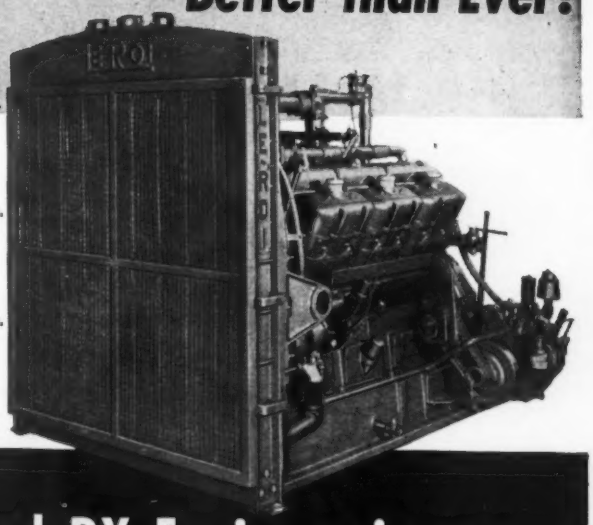

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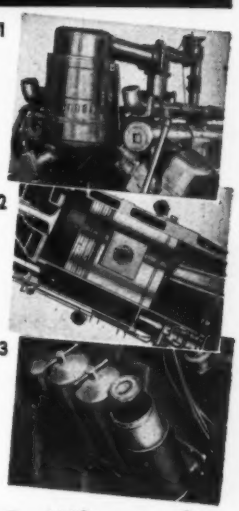

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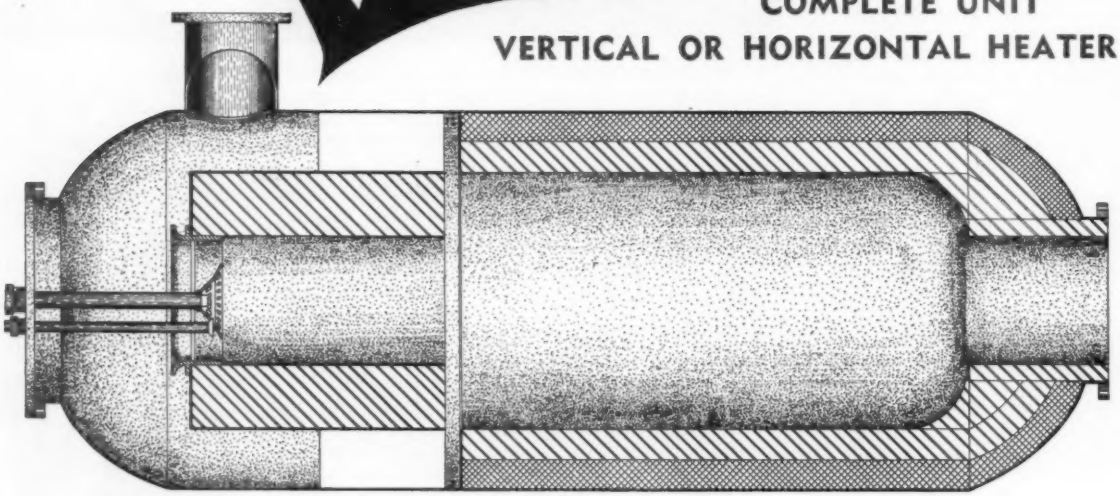

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appears that the main well-completion aims are:

1. Adapting the completion program to the reservoir.

2. Providing completion techniques for low cost.

The science of reservoir engineering has brought about an advanced understanding of the first of these aims and consideration of the basic principles involved has progressed fairly rapidly in most producing areas. The second listed aim is one that is readily understood by ony operator and in which he may exercise his own imagination for a great deal of personal satisfaction. It is this completion technique phase of well completions for which development is proposed in the following discussions:

Cementing.—Improve technique of mixing constituents of modified low-tensile-strength cement. Develop cementing technique that will improve the bond between formation, cementing material, and pipe.

Perforating.—Improve bullet perforators to obtain a minimum of 4 to 5-in. penetration. Improve jet-perforating methods to eliminate the carrot slug and to provide a more uniform and smooth shot hole with a diameter of at least $\frac{1}{16}$ in.

Sand exclusion—gravel packing.—Develop a low-cost placement fluid which will have a minimum plugging effect on the formation and the gravel pack. Such fluid should not change the relative permeability of the producing formation so as to bring about premature gas or water encroachment.

Sand exclusion—plastic consolidation.—Improve placement techniques for the plastics.

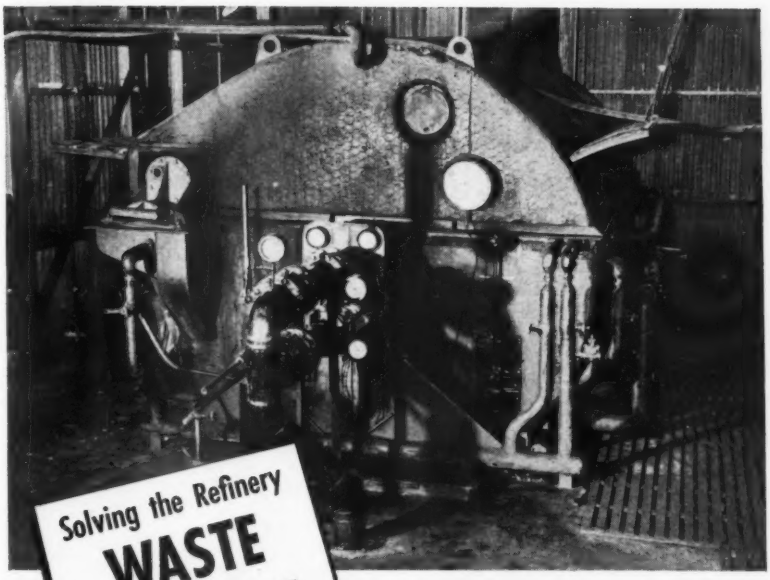
Changes in formation productivity.—Evaluate factors entering into hydraulic formation fracturing. Determine effects on formation and whether or not they may effect subsequent producing operations, such as secondary recovery. Determine cause, magnitude, and remedy for formation plugging adjacent to the well bore.

Flow of fluids into wells.—Develop the equipment and technique for satisfactorily determining rate of flow and kind of fluid entering the well from each increment of producing formation open to the well bore.

Logging.—Strive toward the development of a logging system which will provide all required quantitative and qualitative information on penetrated formations.

Electric logging.—Provide improved methods of evaluating present electric logs. Determine reliability of use of resistivity logs for determining fluid content.

Coring.—Develop a low-cost side-



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Trap residues—separator box emulsions—sludges . . . the Oliver Precoat Filter can effectively handle these wastes by dewatering sludges and breaking oil-water emulsions, resulting in stocks for refinery re-run and water ready for disposal in public streams. For example, a refinery is obtaining an oil phase carrying only 2/10 of 1% sludge and only a trace of water; the water phase is comparatively oil-free.

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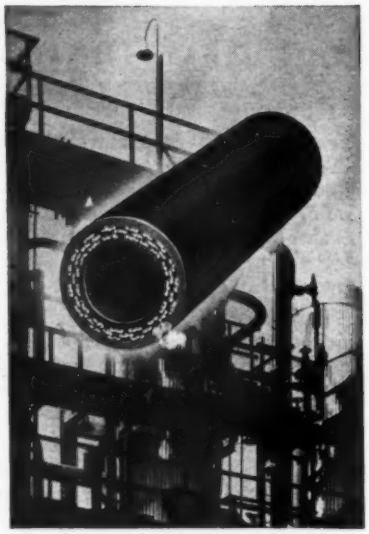

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wall coring device which will provide cores satisfactory for laboratory analyses.

Multiple (dual) completions.—Develop more positive zone isolation equipment and satisfactory dual-lift equipment. Also, develop a simple and automatic indicating method of detecting faulty isolation of zones.

Completion fluids.—For the various drilling fluids, determine their effect and persistence on such effects on producing formations; and develop satisfactory low-cost drilling fluids or other corrective measure to handle such effects.

Drill-stem tests.—Develop a method of indicating instantaneously during drilling operations the points for drill-stem testing. Develop wire-line or other type of testing or sampling device which will permit sampling the fluid content of formations during drilling operations and without the necessity of removing the drill pipe from the hole.

Permanent type original well completion.—Because of the high cost involved in moving in workover rigs and other heavy equipment normally used in performing workover operations, it would appear desirable that an original well completion be evolved that eliminates the need for further use of such equipment. The authors propose the permanent type original well completion as a solution. This type of completion would use light wire-line equipment for repair and reconditioning. The essential features and elements of this type of completion are:

1. Set open-ended bottom of the tubing at a point above that producing formation, Fig. 3. The tubing is set permanently at this position to permit workover and repair operations for all productive zones.

2. Use wire-line retrievable tubing extension, Figs. 4 and 5. With this arrangement for changing the effective bottom of the permanently set tubing, it is possible to perform all washing, cement placing, and other operations which are normally performed with a movable string of tubing in conventional workover operations. This tubing extension arrangement can have a variable setting depth and can be run and retrieved through the tubing on a small wire line.

3. Use perforating equipment small enough to pass through the tubing, Figs. 4 and 6. A perforator small enough to run through the tubing can be lubricated into and out of the well for the original completion and subsequent workover operations. It is preferred to have oil or other fluid of light hydrostatic head in the well while perforating so as to avoid an unfavorable pressure differential against the formation when the formation is perforated. This also will

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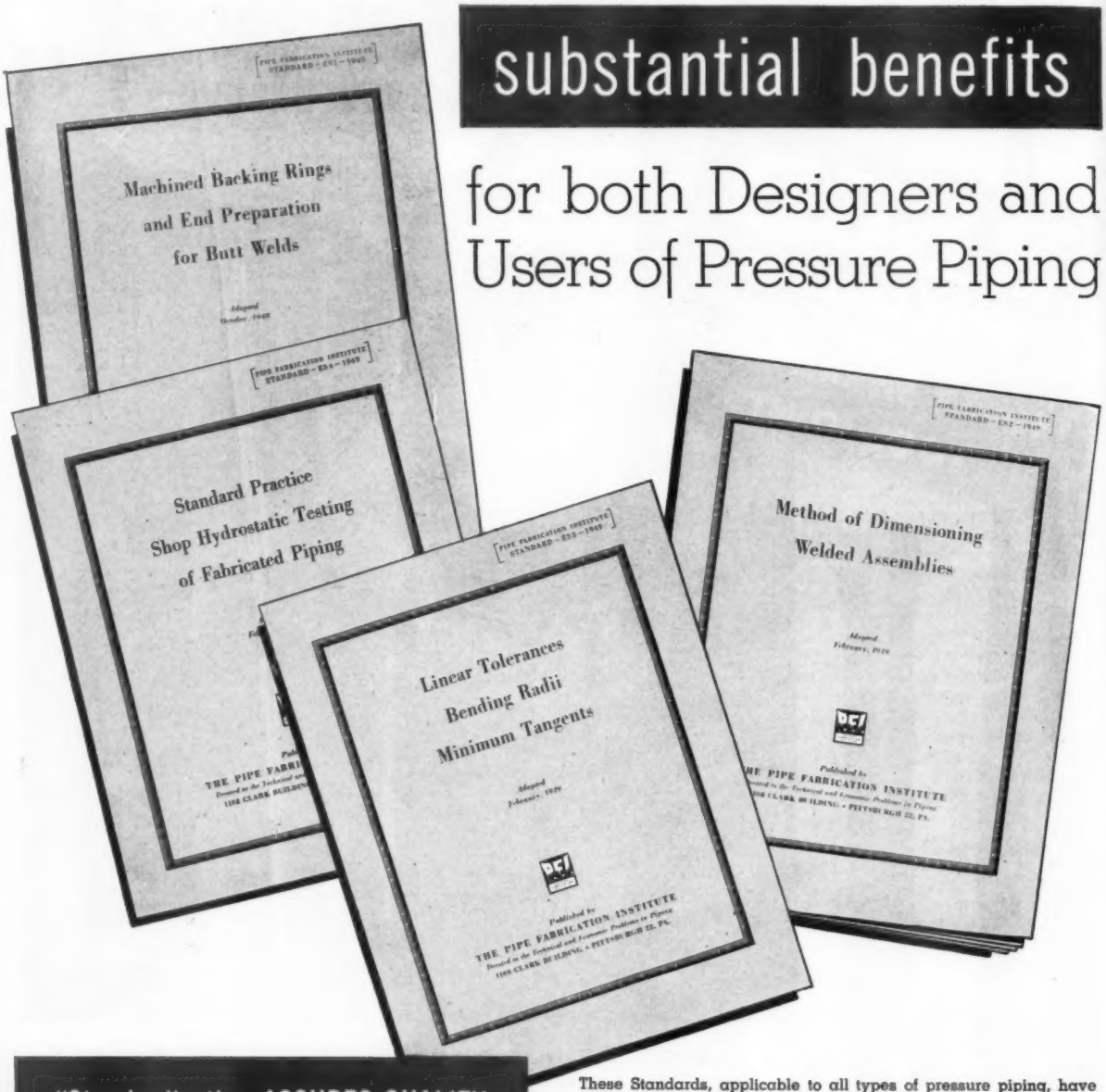
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eliminate, in many cases, the need for swabbing or other "bringing-in" operations.

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More Gasoline From Less Crude

PROGRESS.—Oil refining processes have been advanced by petroleum engineers to the point where today's 20-gal. tankful of automobile gasoline can be obtained from one 42-gal. barrel of crude oil. That same tankful 30 years ago would have required 2 bbl. of crude, while in 1910 refineries had to process 4½ bbl. of oil to squeeze out 20 gal. of gasoline. On top of that, today's gasoline is an infinitely better fuel.

Research "Peps Up" Gasoline

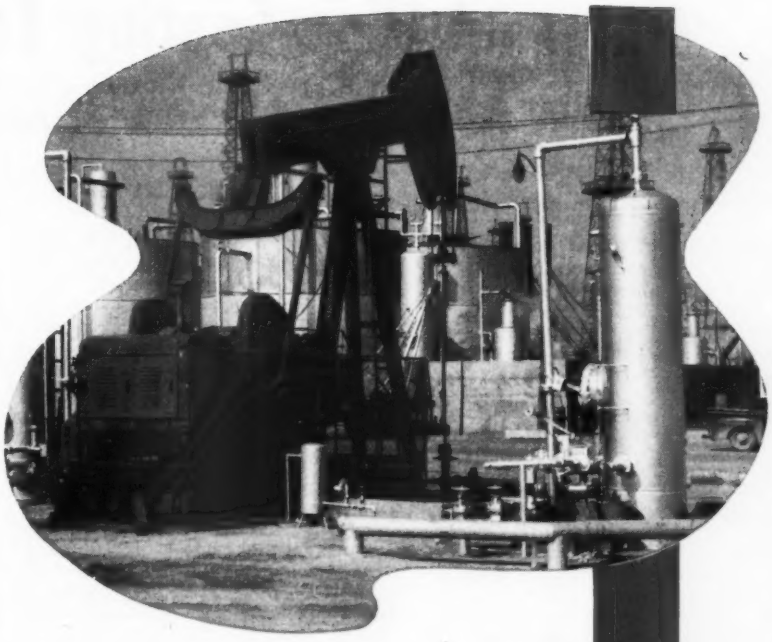
PROGRESS.—Thanks to continued oil-industry research and refining progress, the average regular-grade gasoline being sold today exceeds in antiknock qualities the best premium-grade gasoline of 20 years ago. It is better, in fact, than the aviation fuel which carried Charles Lindbergh across the Atlantic in 1927.

Benzine Now Made From Oil

PROGRESS.—Commercial production of benzene from petroleum is now under way at a plant in Texas at the rate of 3,000,000 to 5,000,000 gal. a year. Another plant is expected shortly to begin benzine manufacture in California. Once obtained almost solely by processing coal, benzine is used in making nylon and other synthetics and plastics.

Diesels Replace "Iron Horse"

PROGRESS. — American railroads installed 1,127 new locomotives during the first 6 months of 1950. Of these all but five were diesel engines. This was the largest number of locomotives installed in a comparable period since 1923. As of July 1 this year, there were 1,000 locomotives on order, which included 973 diesel, 23 steam, and 4 electric.



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Internal Pipe-Coating Techniques

. . . A review of recent developments

by J. K. Alfred

INTERNAL corrosion of pipe lines is a major problem in producing areas where oils with a high content of hydrogen sulfide are prevalent. Many previous papers have discussed the mechanism of such corrosion, as well as the frequency of resultant pipe-line leaks and their staggering costs.

Other means of internal-corrosion mitigation are in use, or have been tried, with various degrees of success. These include hydrogen sulfide elimination by chemical additives, oxygen reduction by tank shutoff valves, brine and water elimination by gravity settling, increased stream velocity, and regular line-scraping programs. Developments of these types are still progressing, but the most reliable means developed to date are internal linings which prevent the oil and its entrained corrosives from coming in contact with the pipe walls.

A "hot spot" for internal corrosion is the Permian basin of West Texas, and it thus is an ideal location for the development of preventive measures. Here three methods of combating such corrosion by lining the pipe with protective coatings have caused much local interest. They are:

1. Plastic lining applied in place.
2. Cement lining applied in the mill or local plant.
3. Cement lining applied in place.

Plastic Coating in Place

The application of plastic on steel as a protective coating is not new in our industry. Most large companies have had some experience with plastic coatings on the inside of storage tanks or pressure vessels, or perhaps in pipe. Usually, however, the application has been made by brush, spray equipment, gravity flow, or dipping.

Late in 1947 a process was introduced in the Permian basin for cleaning and coating the interior of a pipe line in place. It uses the Curtis-Tomlinson patent. The method involves the use of two double-opposed rubber plugs for the purpose of containing the cleaning medium or the plastic coating fluid in the pipe. These plugs are forced through the pipe line, at controlled speeds, by compressed air or inert gas; thus the pipe walls are cleaned by friction or pressure, and they are coated by wiping action. The assembly is shown in Fig. 1.

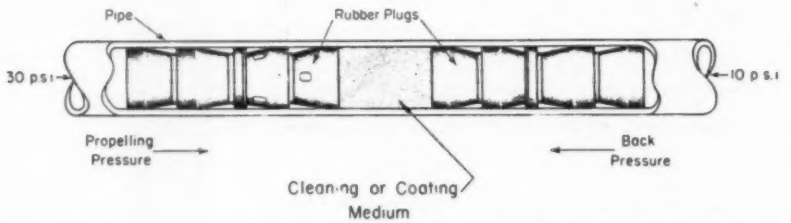

Fig. 1—Two double-opposed rubber plugs contain cleaning material or coating plastic within the pipe.

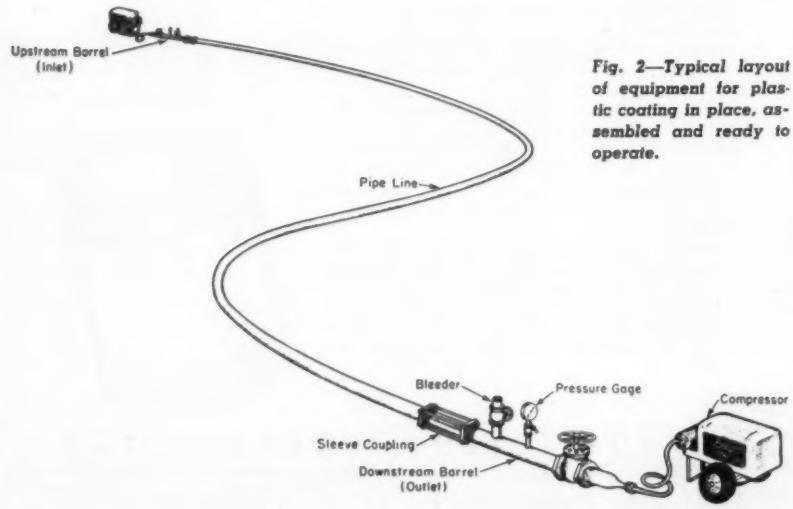

Fig. 2—Typical layout of equipment for plastic coating in place, assembled and ready to operate.

THE AUTHOR

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This paper was presented at the A.P.I. thirtieth annual meeting, Los Angeles, November 9-17.

Each rubber plug comprises four truncated cones, two on each end, and joined in the center by a disk to make one unit. For any given pipe size, these plugs are made with their large diameters approximately ⅛ in. greater than standard inside diameter of the pipe. They are molded of first-grade neoprene, without internal reinforcement.

Other equipment required for the application includes:

Two portable gasoline-engine-driven air compressors, capable of delivering approximately 110 cu. ft. per minute at 120 psi.

Sufficient lengths of pipe or hose to connect one compressor to each end of the section of pipe line to be coated.

Two loading barrels, of the same diameter as the pipe to be treated: One end of each of these has a reduced connection and a pressure-regulating valve to receive the air line, and the other is plain-end. These barrels also have a top connection with a combination loading-and-bleeding valve, and a pressure gage.

Two sleeve-type mechanical couplings capable of holding at 800-psi. line pressure.

Miscellaneous cleaning and brushing apparatus which will be described further in the sequence of an application.

A typical layout of this equipment,

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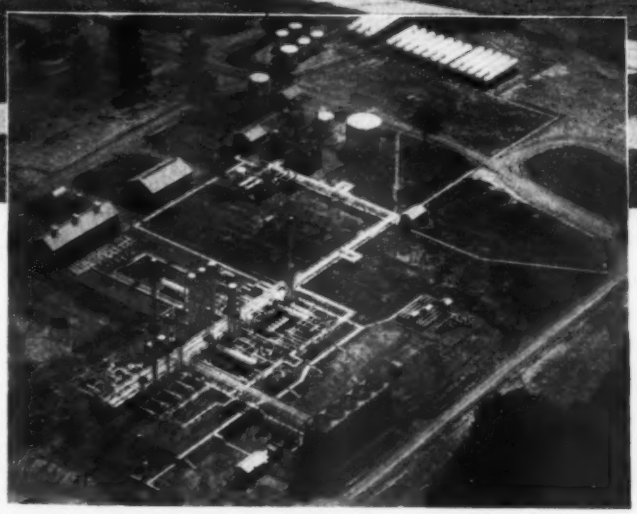

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ready for operation, is shown in Fig. 2.

Air piping is connected, and one of the plugs is placed in the upstream loading barrel. In the first stage of operation, various cleaning devices are then inserted into the barrel against the first plug. The second plug is placed in the pipe, and the barrel is coupled to the pipe line and connected to one of the compressors. At the other end of the line, the downstream loading barrel is connected, and air piping is completed to the second or downstream compressor.

The downstream compressor is started first, and a pressure of 10 to 30 psi. is built up. Then the upstream compressor is started, and the same pressure is obtained in the line—thus producing a condition of equilibrium. At the downstream barrel, pressure is reduced manually through the bleeder valve; this causes the two opposed plugs to move down the pipe line, carrying their contained load of either cleaning or coating material.

Rate of travel of the two plugs is controlled by the amount of pressure reduction at the lower end. When the plugs and their charge reach the downstream end, pressure is again equalized, and the direction of travel may be reversed in the cleaning operation by bleeding at the upstream end of the line.

One pipe-line company has made a rather extensive use of this method to plastic-coat the interior of its lines in some of the most corrosive fields of the Permian basin. This company reports the following steps as a typical application, the same being on a 4-in. medium-pressure oil-gathering line, 7,400 ft. long, which had been in service approximately 4 years:

1. The line was drained; then disconnected at both ends; and then turned over to the cleaning-and-coating contractor.

2. By the use of the loading and unloading barrels, one double-opposed plug was run through the line by compressed air to determine that it was clear and that oil pockets were emptied.

3. Another single plug, pushing circular wire brushes in front of it, was run as a preliminary cleaning operation.

4. Two plugs then were run with wire brushes, and with a cleaning solvent contained between them. This operation was reversed and repeated for a total of six trips.

5. Then a single plug, pushing large wads of toilet tissue, was run through. This was followed by another trip, pushing several gunny sacks. Runs pushing toilet tissue and gunny sacks were alternated seven times, with the gunny sacks wiping and the toilet tissue showing the degree of cleanliness.

6. Two plugs, with steel-lathe cuttings and shop-patterned scrapers contained between them, were passed slowly down the line. This process was reversed and repeated for a total of six trips, each taking approximately 30 minutes.

7. The line then was tested for leaks, with 120-psi. air pressure.

8. More gunny sacks and toilet tissue were pushed alternately through for wiping and checking cleanliness. Six more trips were made.

9. Then a pretreatment of amine solution, contained between two plugs, was run to dispel moisture and to neutralize sulfur products—thus producing a paint-accepting surface.

10. A plastic prime coat was applied by containing the liquid between two plugs, with the compressor working, and with a pressure of approximately 30 psi. at the upstream end. Time required was 30 minutes for the trip, during which 25 gal. of primer were used; 4.5 gal. of primer were pushed out ahead of the leading plug, through the bleeder connection at the downstream loading barrel, into a ready container. Ends of the pipe were opened, after which compressed air was blown through for 6 hours to dry the primer.

11. A plastic-finish coat then was applied in the same manner as the primer. The time required was again 30 minutes, during which 35 gal. of vinyl plastic were used. The line was again opened, and air was blown through for 12 hours to dry the final coat. This completed the application, after which the pipe line was reconnected back into service. The total time required for the job was 2 days.

Although this method of applying plastic coating to the inside of pipe lines is relatively new, the company mentioned has used it to apply vinyl and polyester plastics of its own choice. Its first line was coated about 30 months ago, and since then it has used this method of application on 12 different sections of gathering and feeder lines, including 35,523 ft. of 3, 4, 6, and 12-in. pipe. With but one exception, all coating jobs have been performed on old pipe ranging from 1 to 12 years in prior service.

Before a contract job is accepted, at least one inspection section of each line is cut out and examined. Whenever feasible, these sections are reset in the line with mechanical couplings so that they may be removed and inspected at regular intervals. This provides useful data on the condition of the various coatings under different services, and it also gives an indication in the event the plastic begins to fail. In this 2½-year period only one of the 12 coated sections has failed. This occurred, and was detected, during the drying operation before the line was placed in service; therefore, it was cleaned out and recoated with a different type of plastic.

Gathering lines in the sour-crude districts served by this pipe-line company have varying service lives, some being as short as 8 months. It was not uncommon to have to raise and turn some lines 90° after only 1 year's service. None of this company's lines, with plastic-coated interiors applied by this process, has had a single inside corrosion leak to date.

Application of plastic coatings in place by this process vary in cost only slightly, depending on whether the pipe line is new or second-hand. Current quotations on average second-hand lines for cleaning and lining with one primer and one finish coat are:

Pipe size (in.)	Cost per foot
3	$0.22
4	0.23
6	0.31
8	0.39
10	0.48

The prices include cleaning materials and customer's choice of plastics. Spot-welding, patching, and other repairs (if required) cost extra, and necessarily are done on a cost-plus basis.

To compare costs of this and other methods of internal lining, an actual 4-in. gathering line 7,400 ft. in length has been used as an example. Other

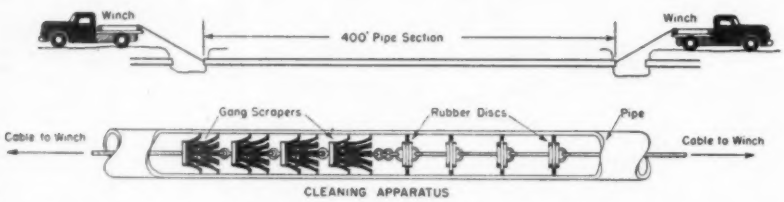


Fig. 3—Wiping disks and scrapers attached to "pull cable" for cleaning interior of pipe line prior to cement-lining in place.

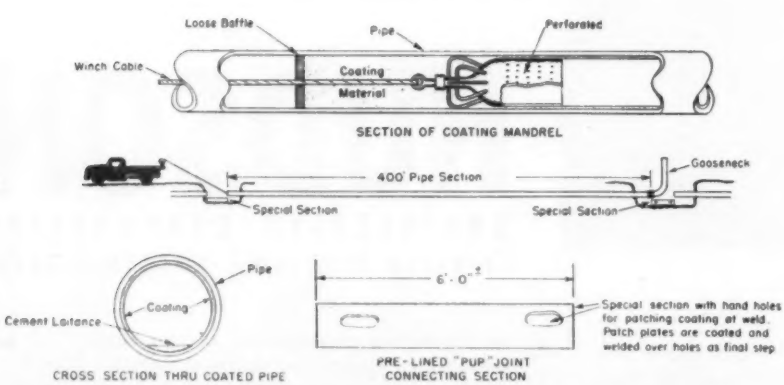
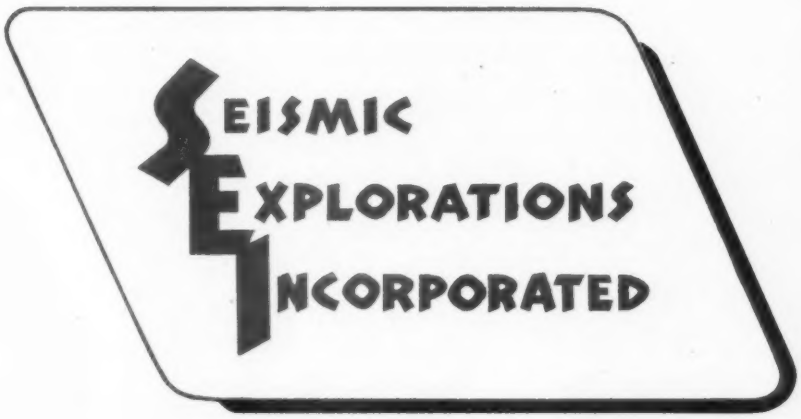


Fig. 4—Typical 400-ft. pipe sections, showing the cement lining in place.



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prices per foot used in the costing are:

Application—	Cost per foot
New pipe	$0.80
Lay new pipe	0.26
Take up old pipe	0.16
Sell old pipe as junk	0.15
Sell as second-hand usable	0.40

This 7,400-ft. line was actually lined with plastic in 1949. In the 10 months prior to its coating 21 leaks occurred from internal corrosion. This caused a loss of 740 bbl. of oil. The cost of leak repairs, and of oil and damage losses, totaled $2,898.

Replacement of this line with new pipe, including takeup of the old, would have cost $9,350. (No allowance is included for sale of old pipe.) To strip out, raise, and turn 180° would have cost $2,600. The cost to apply the plastic coating in place was $1,698—which, based on savings from leak reduction, and assuming no increase in leak frequency, would indicate a payout of the expenditure in 6 months.

Advantages of this method of line protection are:

1. The pipe does not need to be removed and relaid.
2. Outside protective coatings are not disturbed or damaged.
3. Damages to rights-of-way are relatively small or negligible.
4. The friction factor is improved, thus providing some increase in flow rate.

Disadvantages are:

1. The line must be taken out of service for varying lengths of time, depending on the interior condition of the pipe. It probably would not be applicable on long feeder lines without the use and added cost of a temporary bypass line.
2. A complete coating job cannot be assured in spite of frequent removal of inspection sections.
3. If compressed air is used as a driving medium, the hazard of explosion is prevalent.
4. Damage to coating may be caused later by use of plug-type scrapers.

Cement Lining

Pipe with interior cement lining has been used in water lines for more than 100 years. However, in the oil industry, this span of use is hardly more than 20 years, with service principally in salt-water-disposal systems and in refinery flow lines which carry highly corrosive mixtures. Relative few crude-oil gathering or feeder lines were built of cement-lined pipe prior to 1940.

Several manufacturers during the total period have produced steel or cast-iron pipe with cement linings. At least two of the larger tube mills are now marketing pipe which has such an internal coating of cement. Its use, however, requires purchase of new pipe from the mill.

In the past plants have been built to apply cement linings locally in areas of corrosive waters or oils. In the Permian basin such a plant was erected in early 1948. It is located central to the extremely "sour-crude" districts. This plant does not sell pipe; but it furnishes labor and materials, and coats any pipe which its customers send to the plant.

Because the lining may be applied to used as well as to new pipe, an internal cleaning service is also offered by the plant. On used pipe, cleaning is accomplished by butane flame torches with extension handles, so that the hydrocarbon products are burned and scale is loosened. Pneumatic tubing rattlers knock the loosened scale from the pipe walls, and this scale is removed from the pipe walls by alternately swabbing and washing with water. An inspection follows, after which holes are patched or spot-welded. A hydrostatic-pressure test may be applied if desired by the customer.

The materials used for the lining are essentially a mixture of first-grade hydraulic cement, limestone slag, and native West Texas blow sand. These are heated separately for drying, and then are ground together in ball mills to a fineness which will pass a 70-mesh screen.

The materials are wet for mixing in batches, each batch sufficient to line one joint of pipe. The hopper of a mixing machine is loaded with the dry materials. Then—depending on the length, inside diameter, and condition of the pipe (new or used)—a predetermined volume by weight is charged to the mixer. As an example, each linear foot of standard 4-in. new pipe takes 2¼ lb. of dry material; whereas identical used pipe takes 2½ lb.

Each joint of pipe is loaded separately with the wet mixture, which contains sufficient water to allow gravity flow. The joint is capped on each end, and is hydraulically lifted onto the rolls of a spinning machine—where, with the aid of holddown idlers, it is spun at the rate of 950 surface feet per minute for 1¼ minutes.

In this operation, centrifugal force causes the solids of the mixture to take a uniform shape as a smooth, but dense, lining on the interior walls of the pipe. Joints up to 41 ft. in length can be handled in this manner. After the joint has been uncapped and drained, the interior is inspected with mirrors, and each end is hand-finished. A bell-end tool produces square butted edges which are even with the ends of the pipe.

Joints are then loaded on cars and transferred to curing kilns, where they are subjected to a 200° F. steam treatment for 8 hours. The high humidity in this operation retards shrinkage and prevents cracking of the lining. Following this, the lined pipe is allowed to cure at least 24 hours in atmosphere, after which it is ready for service.

The lining thickness thus produced varies only slightly and is nominally ⅛ in. on 2, 3, or 4-in. pipe or ¼ in. on 6, 8, and 10-in. pipe. Being a continuous arch confined to the pipe walls, the lining is self-supporting; therefore, no special handling of the pipe is required other than ordinary diligence in loading and unloading—particularly the avoidance of the use of hooks in the ends of the joints.

Several pipe-line companies are now having pipe from their own stocks coated in this local plant, in the specific sizes and amounts required to fit various jobs, large or small. Plain-end as well as thread-and-coupled pipe is processed as requested.

In laying thread-and-coupled pipe, an overlapping plastic sleeve and a sealing compound are generally used. Plain-end pipe, beveled for welding, is joined in several ways. One company uses a ⅛-in. asbestos gasket, precut to fit the inside diameter of the lined pipe and the lip of the beveled end. Just prior to lineup of the pipe, the gasket is set in place with undiluted sodium silicate (water glass) applied to both faces of the material.

During the welding operation the transfer of heat is minimized, and the sodium silicate forms a corrosion-resistant glazed surface on the interior walls. Welds cut from cement-lined pipe joined in this way indicate well-sealed interior joints, and no damage to the lining. Another company tightly butts the joints together, without standard spacing, and it runs the stringer bead in, using a ⅛-in. or smaller rod. This company also has cut test welds for examination, and it reports no damage to the lining.

Field bends of such cement-lined pipe are restricted to 10° in 20 ft. Sharper curvature requires the use of fabricated bends, which can also be obtained with cement linings applied by hand methods. From current experience, contract costs of laying cement-lined pipe are seldom more than 5 per cent additional to the cost of laying unlined pipe.

In a small trunk line, one company has installed 120,000 ft. of such cement-lined pipe, ranging in size from 6⅝ to 8⅝ in. in outside diameter. This line serves one of the sourest crude fields of the Permian basin, and operates at pressures up to 950 psi. The line was originally laid of plain steel pipe in 1937.

Cement-lined pipe has been laid as a replacement in five increments since 1942—some in sections which had been replaced one or more times previously with plain steel pipe. Only the first increments were laid with pipe which had the lining in place when purchased from the mill. Prior to the laying of the cement-lined pipe, a total of 788 leaks occurred in these five sections. No leaks have developed to date in the cement-lined

pipe, some of which has been in service as long as 8 years.

This same pipe-line company has installed 35,900 ft. of such cement-lined pipe as replacements for 4, 6, and 10-in. steel pipe in gathering systems. Service of the cement-lined sections varies from 8 months to 7½ years; and, although 455 leaks were experienced in the plain steel pipe, none has developed in the cement-lined replacement sections. Another pipe-line company in this area has installed 121,000 ft. of cement-lined pipe in its gathering systems, with excellent results in eliminating internal corrosion problems.

The fact that any amount of either new or second-hand pipe can now be cement-lined locally in the Permian basin has increased the use of this means of controlling internal corrosion of pipe lines. Quotations for this lining service at the plant in Odessa are:

Pipe size (in.)	Cost per foot
2	$0.20
3	0.25
4	0.35
6	0.50
8	0.70

(Jobs more than 10,000 ft. in length receive a 10 per cent discount. If the pipe is second-hand, patching and repairs are done on a force-account basis.)

Consider again the 7,400-ft. section of 4-in. gathering line, cited under "plastic coating," which had a cost of $2,898 for oil loss, damage, and repairs within 10 months. Cement lining, at the local plant, of pipe equally as good as that to be removed would cost $2,590; and laying costs would amount to $1,990. If the expense of taking up and cleaning the old line and turning it to stock in place of the newly lined pipe is added, we get a total of $5,910 for replacing the plain steel with cement-lined pipe.

Again assuming no increase in leak frequency, the savings in "leak expense eliminated" would pay out the cost of cement-lined pipe in 20 months. This figure applies regardless of whether the original pipe is cleaned and coated at the plant and then relaid, or whether other second-hand pipe is coated and laid after which the original pipe is cleaned and returned to second-hand stock. Of course, the latter is the only means by which an extended service interruption can be avoided.

Advantages of plant-coat cement-lined pipe are:

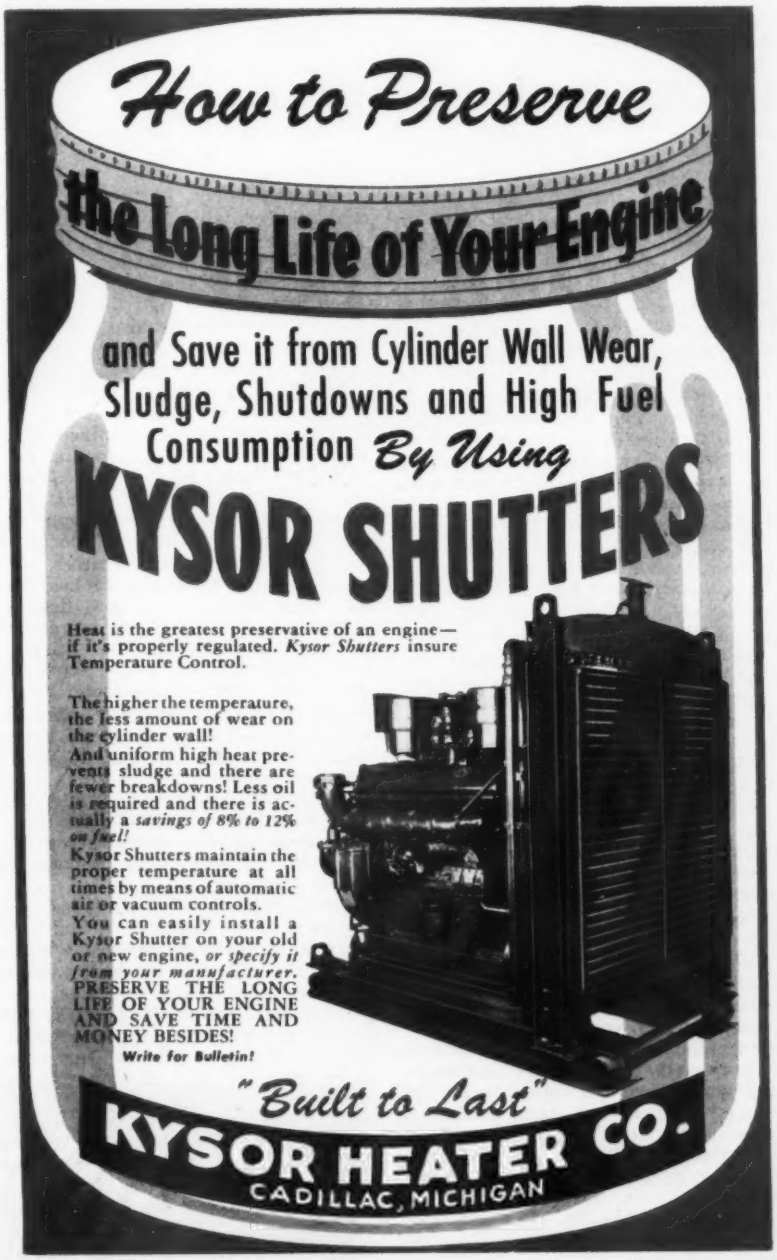
1. By visual inspection, assurance is given that the coating is complete.
2. There is little doubt that the life of the coated line will be 5 to 8 years or longer.
3. No chance exists for fire or explosion as compared to other internal coatings.
4. There is no limitation to operating pressures other than the standards for the particular quality and thickness of pipe which bears the internal coating.
5. No appreciable losses result from operational downtime while cement coating is applied.

Disadvantages are:

1. Construction damages will accrue because of laying and taking up of pipe.
2. Previous external coatings are destroyed.
3. Slightly higher laying costs are involved.
4. Salvage of welded lines which have a cement lining would require higher takeup cost and would result in appreciable loss of inside coating.
5. Additional cost of fittings is required in place of ordinary field bends.
6. Reduction in effective inside diameter might be so critical as to require the use of the next larger size of pipe.

Cement Lining in Place

Pipe has been internally coated in place with cement for 30 years or longer. This process had its inception on municipal water lines, where the cost of replacement or reconditioning of large mains or service laterals was almost prohibitive because of the location of buildings or other permament structures. Its application to oil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pipe lines is quite new. The process is covered by an Australian patent, and an oil tanker-unloading line is reported to have been concrete-lined in the port of Sidney.

A firm performed the first internal coating job of this nature in the Permian basin for one of the pipe-line companies. Basically, the process consists of applying a relatively dry cement-sand mortar to the interior walls of the pipe. This is done by using a bullet-shaped mandrel with its large diameter of such size that the shape of the lining will conform to the thickness requested by the customer. This application is made on short sections of the line, approximately 400 ft. in length, with the mandrel drawn through the sections by cables attached to truck winches. Interior cleaning, prior to the placing of the lining, is accomplished by cable-drawn rubber disks and steel scrapers.

The 24-mile length of crude-oil line which was coated in place in this manner during mid-1949, is a 10¾-in. main gravity-feeder in Lea County, New Mexico. Both new and second-hand pipe of three different wall thicknesses is included in this electric-welded line, laid originally in 1940.

Inasmuch as it was estimated that 90 days would be required to coat the line in place, a 2-mile temporary loop of 8-in. line was laid on top of the ground. This was placed in service to free the 10-in. line for contractor's work. Throughout the entire job it was necessary to move this 8-in. bypass 2 miles ahead and tie it into service; then to take the 10-in. line out of service long enough to drain it, tie in the 2-mile coated section from the rear, and reconnect the loop ahead. As the work progressed, each 2-mile section of 10-in. line was cut into 400-ft. lengths for a "pull."

A typical operation of cleaning and lining one of these lengths was begun by excavating; then cutting a 6-ft. piece from each of the ends. A ¾-in. cable was threaded through the section with the use of oil-well sucker rods. This cable was attached to several rubber squee-gee disks, which were slightly oversize to the inside diameter of the pipe, and to spring-steel gang scrapers. This apparatus (Fig. 3) was repeatedly pulled through the pipe line by a truck winch until neither fluid nor scale discharged.

The lining material, composed of washed sand and common portland cement, was mixed by hand in an ordinary mortar box. The sand was of two grades (fineness not disclosed), and was shipped in from the Pacific Coast in paper bags—thus making it more costly than the cement. Only sufficient water was used to make the mix fluid. No slump tests were taken.

A long-radius elbow, fixed to a vertical section of 10-in. pipe approximately 8 ft. long, was set in place and coupled to one end of the line. A free baffle in the form of a rubber disk, oversize to the inside diameter of the pipe, was threaded loosely on the "pull cable." Mortar was then loaded through the "gooseneck" into the line. This is shown in Fig. 4. The weight of the mix packed the mortar tightly against the baffle. With the lining charge completed, the gooseneck was dropped from the end of the pipe and the mandrel was connected to the end of cable (Fig. 4).

This projectile-shaped mandrel, approximately 30 in. long, was tapered with guides for centering it within the pipe. The rear 12 in. were cylindrically shaped of a diameter to form a ⅛-in.-thick cement coating on the pipe walls. This section was perforated; thus the water in the mortar was pressed out and allowed to settle in the bottom of the line. No means of water removal was provided; thus a cement laitance approximately ⅝ in. thick was formed in the bottom of the pipe.

A truck winch pulled the charge and the coating devices down the line at the rate of about 20 ft. per minute. The loose baffle forced the mortar against the mandrel which lined the pipe to the desired thickness. Upon completion of the pull, the entire length was inspected by mirrors for imperfections; then capped for a 48-hour minimum curing period.

Each of the 400-ft. sections was connected by welding in a prelined "pup" joint. Hand holes, 6 in. in diameter, were left open in the top of each end of these short joints and, after welding, the interior area around the weld was hand-coated with mortar. A patch plate, 12 in. in diameter, with its underside treated with coal tar, was then welded over each hole.

This was the operation progressively followed throughout the entire cement-lining job. Work was started in May 1949 and was completed the following August. Because of difficulties encountered, progress varied considerably, but it averaged 2,000 ft. per day. Random test sections were cut from the line by the owner. All were satisfactory with respect to cement coverage and uniformity of the thickness, as well as to smoothness of the surface.

Although many corrosion holes were apparent in the line after it had been cleaned, others were purposely made to test the action of the lining under this condition. The result was complete penetration of the holes by the mortar and sealing of the holes satisfactorily for gravity flow-line pressures. Prior to this coating job, oil leaks were numerous in the bottom half of this line. A series of inside-diameter measurements taken during the progress of the work indicated metal losses up to 75 per cent of the original pipe-wall thickness, and not uniformly in the bottom quadrant. Today, after 1 year in operation, no leaks have been experienced.

Current quoted prices on cement lining of oil pipe lines in place, including cleaning, are:

Pipe size (in.)	Cost per foot
4	$0.82
6	1.06
10	1.50

If a bypass line is required, this must be provided at the customer's expense.

For comparison, the example used under plastic coatings in place is taken again to indicate profitability. This 4-in. gravity line, 7,400 ft. in length, cost $2,898 for oil loss and for leak repair during 10 months. The cost of cement-lining it in place would appear to pay out in 21 months because of savings in leak costs. These figures are based on the assumption that no bypass line would be required for an approximate 4-day shutdown of the line.

Advantages of cement-lining pipe in place are:

1. The line does not require taking up and relaying.
2. Exterior protective coatings are not damaged, because the line is not disturbed.
3. Damage to property owners is relatively small.

Disadvantages are:

1. Assurance cannot be obtained that the pipe has been coated without imperfections.
2. Line operations would be limited to minimum pressures because of mortar-filled holes.
3. Downtime and coating costs would be increased in rough or uneven terrain.
4. Reduction of internal area of the pipe, including cement-laitance deposit, might be so critical as to eliminate this method.
5. Amount of downtime required might also be critical enough to eliminate this process.

Acknowledgment

Appreciation is expressed to the following groups which furnished the information for the paper: Humble Pipe Line Co., Texas-New Mexico Pipe Line Co., Permian Enterprises, Inc., Curtis-Tomlinson Co., and Shell Pipe Line Corp.

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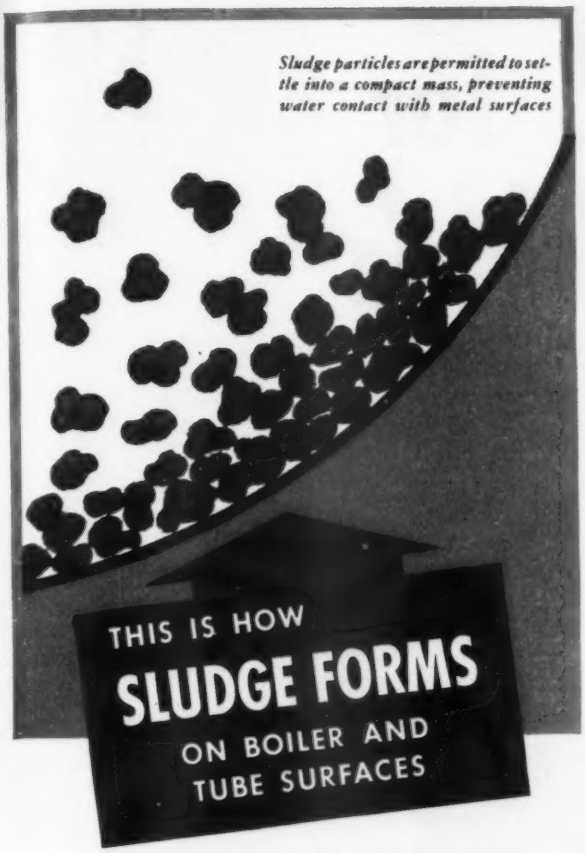
Sludge particles are permitted to settle into a compact mass, preventing water contact with metal surfaces
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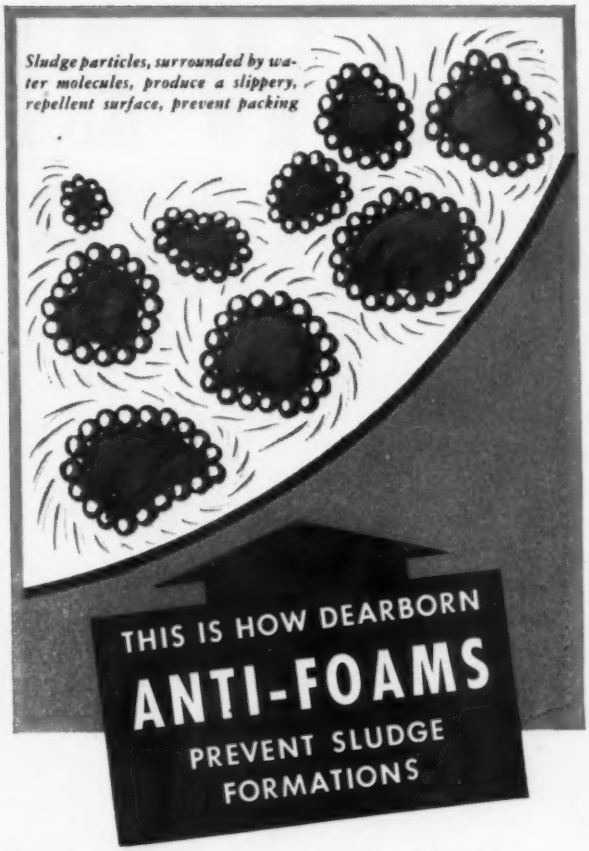
ON BOILER AND TUBE SURFACES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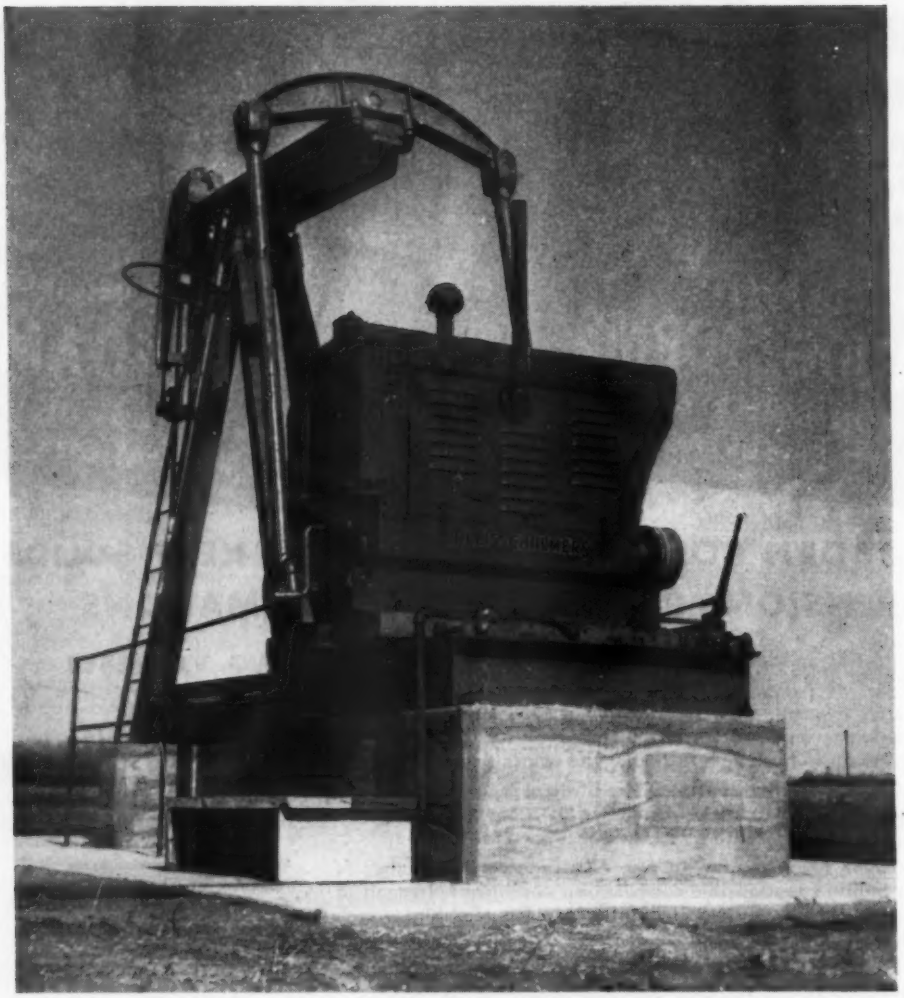

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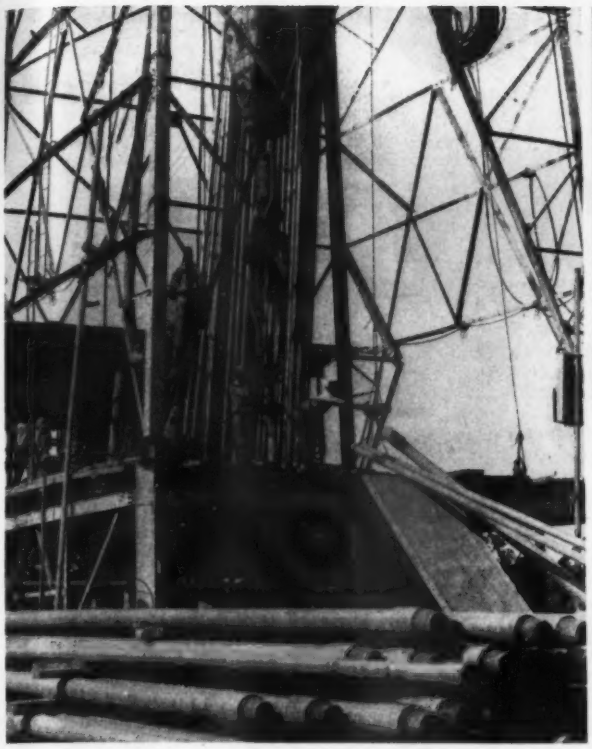

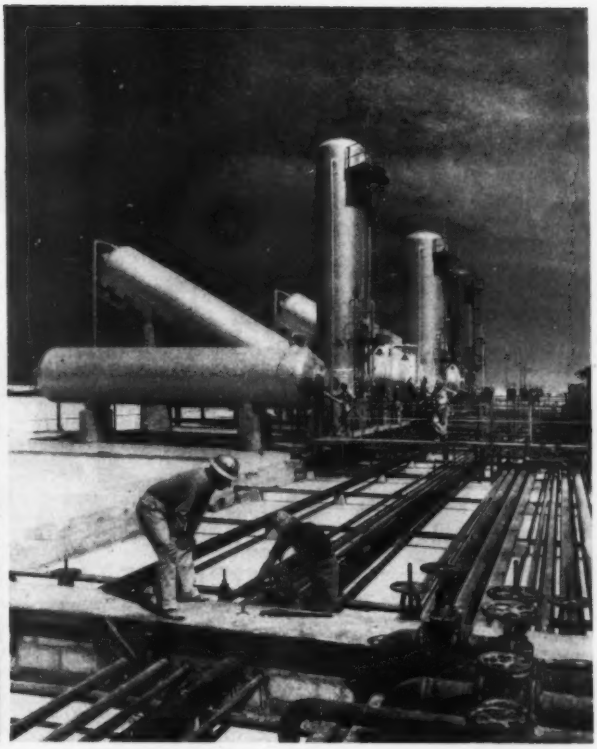

The Gulf of Mexico-Caribbean area and the Middle East are sources of the world's strategic oil supplies. Here are seen a drilling operation in Venezuela, and a refinery treating plant in Saudi Arabia.

STRATEGIC OIL SUPPLIES

The western powers must make it clear to aggressor nations that they intend to maintain control of the Middle Eastern oil. Adequate defense now may well slow down or stop Russia's time table of aggression

by Gustav Egloff*

THE strategic oil supplies of the world are located in two principal areas: the fields bordering the Gulf of Mexico and the Caribbean Sea and the fields in the Middle East. The total world production of crude oil is about 10,500,000 bbl. a day, of which the United States produces about 52 per cent, the Middle East 17 per cent, Venezuela 14.5 per cent, and Russia and her satellites only 8 per cent.

The combined production of the largest producing areas, the United States, Venezuela, and the Middle East, accounts for nearly 85 per cent of current world output. Table 1 summarizes the current production of petroleum by world areas.

*Universal Oil Products Co., Chicago. Paper presented before the lubrication session, Division of Marketing, American Petroleum Institute, thirtieth annual meeting, November 14, Los Angeles.

To compensate for their lack of petroleum supplies, Russia and her satellite countries use the expensive processes of coal hydrogenation and oil-shale retorting to produce additional supplies of oil. It is difficult to determine just how much oil is produced from these processes. In eastern Germany, current plans call for the production of 20,000 bbl. a day of automotive fuels by the hydrogenation of lignite. In Czechoslovakia, a coal-hydrogenation plant is available for producing 30,000 bbl. of gasoline a day. It seems reasonable to estimate that at least 100,000 bbl. a day of synthetic liquid fuels from coal and oil shale are being produced in Russia and satellite countries. The combined total of crude petroleum and synthetic oils probably amounts to about 1 million barrels a day which is less than 10 per cent of total world production

The Middle East Countries

Of all producing areas, the Middle East is by far the most challenging in the world at the present time. It includes the countries of Iraq, Iran, Saudi Arabia, Kuwait, and Bahrein, and has a land area equal to 67 per cent of that of the United States. Control of the Middle East fields is now entirely vested in western democratic nations. Forty-seven per cent is held by the British, 41 per cent by Americans, 6 per cent by the French, and 6 per cent by the Dutch.

Most of the knowhow for exploration and well drilling has been supplied by American and British operators who gained their experience in the oil fields of the United States and other countries in the Western Hemisphere. They have developed this area at great cost and considerable financial risk.

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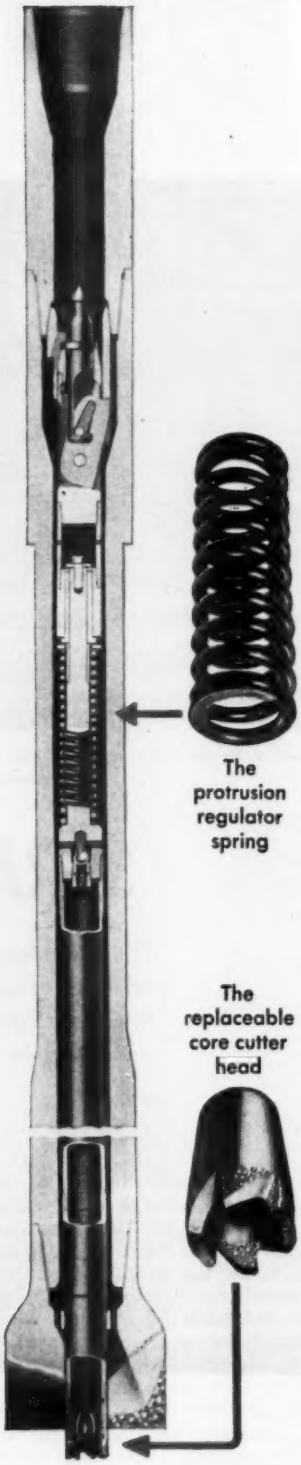

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TABLE 1—WORLD CRUDE-OIL PRODUCTION—JULY 1950
(1,000 bbl. per day)

Western Hemisphere:	
United States	5,504.0
Venezuela	1,533.3
Mexico	195.2
Other	353.2
Total (71.8 per cent)	7,585.7
Western Europe:	
Germany	21.9
Netherlands	14.4
Other	5.1
Total (0.39 per cent)	41.4
Russia and Eastern Europe:	
Russia	730.0
Romania	85.0
Austria	25.0
Other	23.6
Total (8.15 per cent)	863.6
Middle East:	
Iran	691.2
Iraq	128.5
Kuwait	363.7
Saudi Arabia	558.6
Egypt	39.9
Other	66.3
Total (17.5 per cent)	1,848.2
Other Asia:	
Indonesia	130.0
British Borneo	82.0
Other	23.1
Total (2.2 per cent)	235.1
Grand total	10,574.0

Native labor was entirely uneducated for the kinds of jobs necessary to oil production and refining. In addition to this task of training labor, a large number of employes had to be transported from the United States and western Europe. Whole new towns had to be built with living quarters, sewage and water systems, schools, and recreation facilities to make these areas habitable. Oil companies of the United States, Britain, France, and Holland have invested superhuman effort in these Middle Eastern fields and have every right to the oil therefrom.

Middle East oil production is remarkable in many ways. The production per well averages over 5,000 bbl. a day in all the Middle East fields while some wells yield as high as 15,000 bbl. a day. At present there are only about 300 producing wells. In the United States by contrast there are about 450,000 producing wells averaging about 12 bbl. a day, although there are much higher producers in some fields. The average production per well for the whole world is about 20 bbl. a day.

United States and World Data

Oil production is backed by enormous reserves. The areas of greatest reserves, however, do not always correspond to the areas of largest current production. The greatest development has occurred in the United States where nearly a million oil wells have been drilled since the beginning of the industry in 1859. Table 2 shows the accumulated production of petroleum in various world areas since the industry began.

TABLE 2—CUMULATIVE PETROLEUM PRODUCTION THROUGH 1949
(Thousands of barrels)

World	61,737,998
United States	38,939,286
Venezuela	5,000,000
U.S.S.R.	6,292,473
Total Europe	8,045,208
Middle East	3,371,677

The data show that the United States has produced 63.7 per cent of all the oil which has been brought above the ground. Despite the fact that the higher producing rate in the United States would be expected to leave relatively small amounts of oil for the future, the proven reserves have increased throughout the years so that approximately the same ratio of reserves to production has been maintained. Data for 5-year intervals since 1920 are given in Table 3.

TABLE 3
Estimated Proved Reserves of Crude Oil, Natural-Gas Liquids, and Total Liquid Hydrocarbons in the United States, by Years
(Thousands of barrels)

Year	Production during years	Proved reserves end of year	Ratio of reserves to year's prod.
1920	442,929	7,200,000	16.3
1925	763,743	8,500,000	11.1
1930	898,011	13,600,000	15.1
1935	996,596	12,400,000	12.4
1940	1,351,847	19,024,515	14.1
1945	1,736,717	20,826,813	12.0
1949	1,996,669	28,586,000	14.3

Many geologists have estimated the ultimate amount of oil that will be discovered in the world's sedimentary-rock formations. With increasing knowledge of earth formations and the types of structures in which oil is most likely to be found, the estimated reserves have steadily increased over the years. Some geologists believe that 1,500 billion barrels more of petroleum will eventually be obtained from the earth's oil-bearing rocks. The amount which will be recovered from formations under land areas is estimated to be between 500 and 600 billion barrels, approximately 10 times the cumulative world production to date. Reserves of 1,000 billion barrels are estimated to be under the continental shelves.

Distribution of Oil Reserves

As to the distribution of the oil reserves, the geologists calculate that of those under the land areas about 150 billion barrels are yet to be discovered in the Western Hemisphere and 350 billion in the Eastern Hemisphere. The most commonly accepted figure for the United States at this time is 100 billion barrels. Table 4 gives probable resources.

Of the ultimate resources in the above estimate it appears that about 25 per cent are in the Russian zone of domination and 75 per cent under the control of the western democratic nations. The estimates are based on known oil-bearing formations. Past experience has shown that oil is also discovered in unpredictable areas and it is safe to assume that much greater quantities will be found than are predicted at present. Even though they are not, the estimated reserves will supply oil for 500 years at the present rate of consumption. According to these data, there is no foreseeable oil shortage.

TABLE 4—LAND-AREA OIL RESERVES

Country or region—	Estimated resources: Billion bbl.	Per cent
United States	100	16.7
Venezuela-Colombia-Mexico	45	7.5
Other	65	10.8
Total Western Hemisphere	210	35.0
Russia-Siberia	150	25.0
Middle East	150	25.0
Oceania (East Indian Archipelago)	35	5.8
Other	55	9.2
Total Eastern Hemisphere	390	65.0
Total world	600	100.0

Refineries, Locations and Capacities

In any emergency, the location and capacity of refineries is of almost greater importance than production and reserves. Total world refinery capacity is about 11,600,000 bbl. daily of which 6,700,000 bbl. is located in the United States.

Next in capacity are the refineries of Latin America which can process about 1,500,000 bbl. daily, 1,000,000 bbl. of which uses Venezuelan crude in refineries at Curacao, Aruba, and Venezuela.

The Middle East has the world's largest refinery at Abadan, Iran, where over 500,000 bbl. of crude oil are charged daily. Other large refineries in the Middle East are the one on Bahrein Island which charges 150,000 bbl. a day and the one at Ras Tanura which charges 140,000 bbl. The products of the Middle Eastern refineries are practically all shipped to western European countries because local demands are almost zero.

The refineries in western Europe, operating mainly on imported crude, are being enlarged under ECA sponsorship so that by 1952-53 they may be able to supply domestic demands for petroleum products. Table 5 shows the refinery capacities in these countries at the end of 1949, and the projected increases in throughput.

The table shows that in the next 2 or 3 years the capacity of western European refineries will be increased by 738,000 bbl. a day.

The throughput of Russian refineries at the end of 1949 was 680,000 bbl. of crude oil a day. Over 100,000 bbl. of oil were charged to refineries in Russian dominated countries. Including synthetic oils from coal hydrogenation and oil-shale retorting it seems probable that Russia and her satellites are refining around a million

TABLE 5—ECA RECOMMENDATIONS FOR INCREASING EUROPEAN REFINING CAPACITY
(Barrels per day)

	End of 1949	1952-53
Austria	*7,800	12,400
Benelux	7,000	165,000
Denmark	600	16,000
France	250,000	375,000
Greece		8,000
Italy	63,000	146,600
Norway	700	700
Portugal	*6,000	9,200
Sweden	11,500	41,000
United Kingdom	135,000	390,000
West Germany	38,000	94,400
Total	519,600	1,257,300

*1948.

barrels a day of crude petroleum and synthetic oils. Russia is not a highly industrialized country and reportedly has 1,250,000 motor vehicles of all types so that production for peacetime transportation is apparently sufficient. In the event of an emergency, however, its oil production and refining facilities would be inadequate.

The Important Question: Distribution

The data given heretofore will be compared to show the distribution of oil supplies in case of a showdown between democratic and totalitarian countries. The democratic nations which have developed the world's oil fields on their own initiative to their present high capacity, are in control of about 90 per cent of present-day production and about 75 per cent of the estimated oil reserves.

The United States has a production of 5.8 million barrels of petroleum a day at present with another million barrels shut in but available when needed. It also has access to Canadian and Mexican oil without having to rely on transportation by sea.

Nearby are Venezuela and other South American oil-producing nations. We probably can depend on the Venezuela supply in any emergency although the threat of submarine attack cannot be discounted.

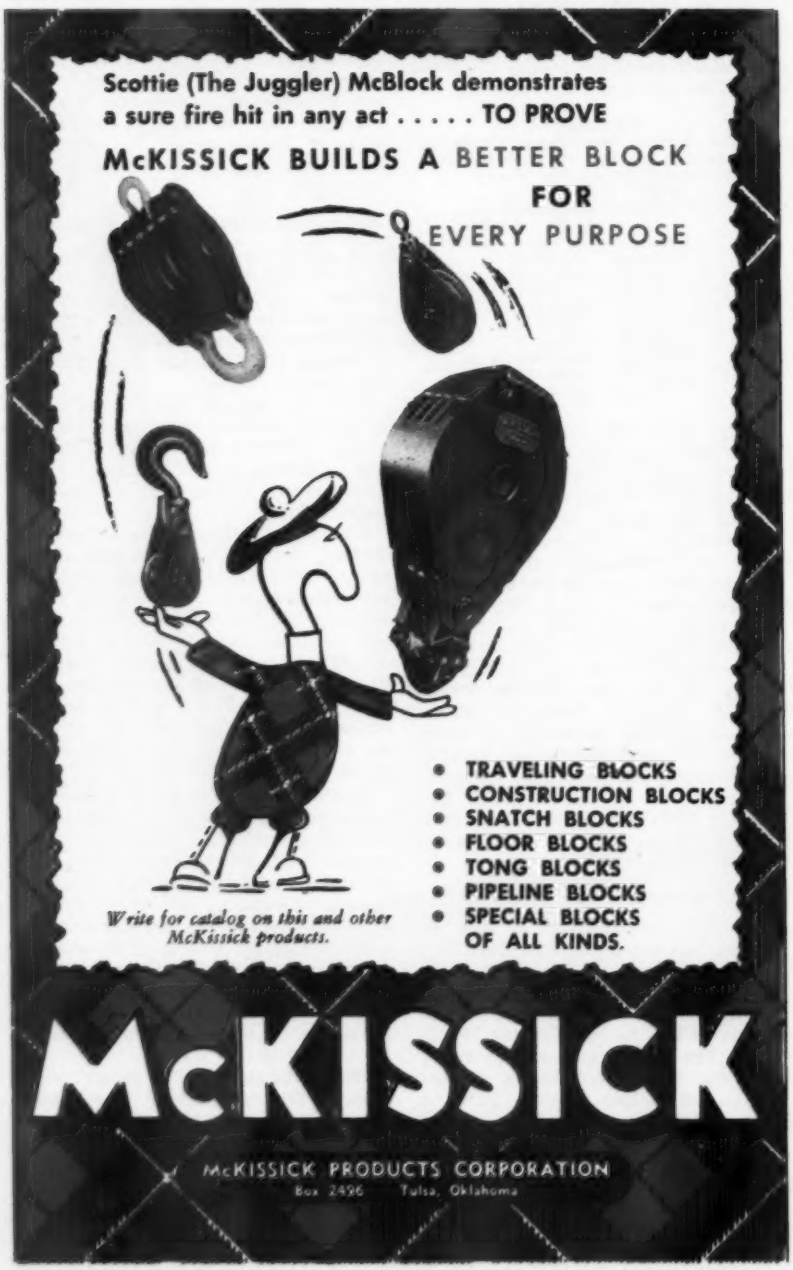
It is evident that the United States has more than ample oil for civilian needs and high military demands. In a long, large-scale war fought thousands of miles away, however, it would be difficult to supply all requirements if our allies were entirely dependent on us for oil.

In any long conflict, Russia would have to get more oil and the Middle East stands as the most obvious point to seize because of its proximity. Control would not only divert supplies to Russia and triple her available resources but also cut off this source of oil from western European countries leaving them more prone to invasion. Russia is reported to be fomenting border incidents and tribal wars in Iran with the evident aim of developing a weak spot which will be ripe for invasion.

The availability of Middle East oil to western Europe in both peace and war is dependent on transportation. Even though control of the Middle East fields remained in friendly hands, western Europe would be cut off from this supply if transportation were disrupted. Heretofore, the oil has been carried entirely by tankers for 3,650 miles around the Arabian Peninsula and through the Suez Canal, but a 1,000-mile pipe line has recently been completed which will carry as much as 500,000 bbl. per day directly to the Mediterranean. In case of war, the pipe line is vulnerable to air attack, but tanker transport is subject to the usual hazards of maritime transportation and the vulnerability of the Suez Canal to air attack. The pipe line is of greatest importance in an emergency because it opens a second route of supply. The pipe line also has the advantages of offering cheaper and faster transportation.

Another point that should be considered is the vulnerability of the large Middle Eastern refineries and storage tanks to attack. In the event of war, every attempt would be made by the opposite side to attack these sources, regardless of who had control over them.

Russia, however, is much less likely to start a war if she does not have this prolific source of oil. By maintaining control in the hands of the democratic countries the tide may eventually be turned against communistic expansion and peace maintained throughout the world.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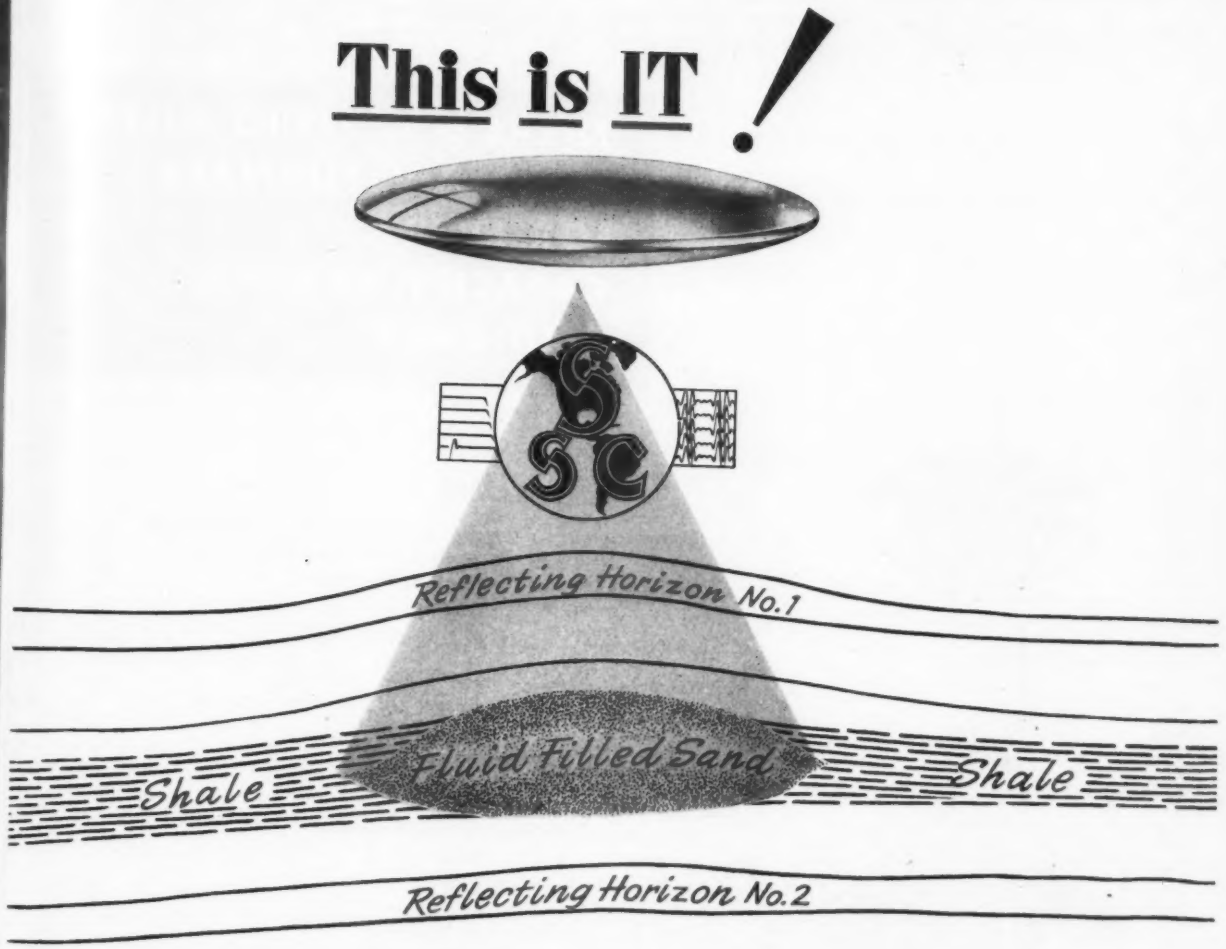

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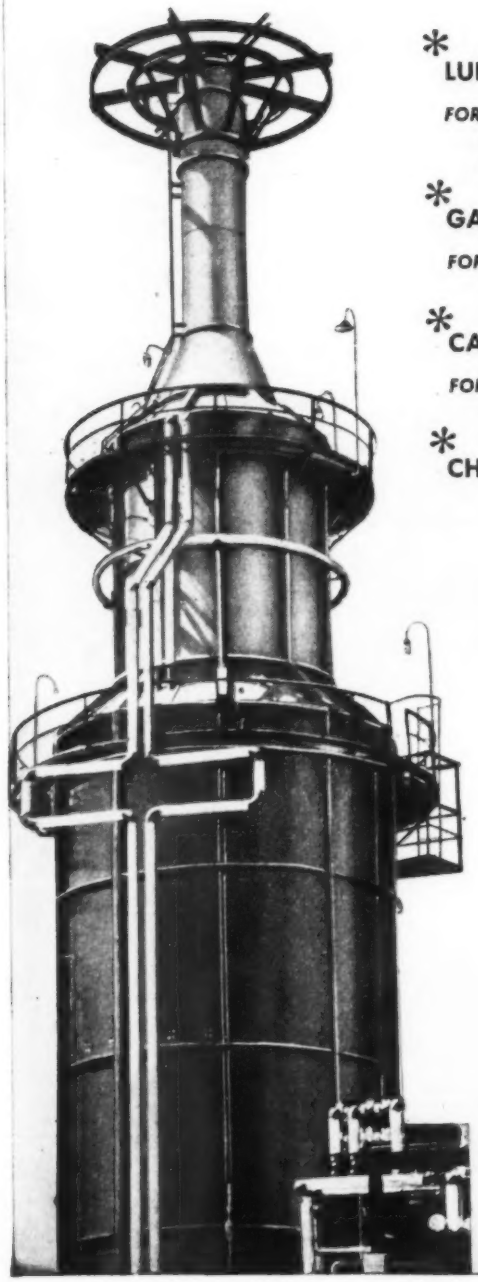

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Fuels for Our Fighting Forces

Logistics demand that number of types of fuels and lubes supplied to combat areas be kept low

by Col. Benjamin S. Mesick

SIMPLIFIED supply and wide range of usability have long been the objectives of the fuels and lubricants program of the army. The present situation in Korea has served to emphasize the need for meeting those objectives, and as soon as possible. We are operating at the end of a 7,000-mile supply line to combat a zone approximately 400 miles long, where the temperature ranges from subtropical in the summer in one section to arctic in the winter in another section of the peninsula.

From the standpoint of logistics, the number of different types of materials to be supplied to such a combat area must be kept to an absolute minimum. A few classes of materials, suitable for use in many applications over a wide temperature range, simplify supply and decrease the possibility of using the wrong material, as might be the case if a wide variety of materials was available for different purposes.

Fuels

As in World War II, it is basic that only one class of gasoline will be furnished to combat theaters. This gasoline is currently described in Military Specification MIL-G-3056, dated September 30, 1949, which is actually the same as the old U. S. Army Specification 2-103C.

With the trend toward higher-compression-ratio truck engines now being produced by the military, and with the development of the air-cooled tank engine, it has been necessary to consider improvement in this Specification MIL-G-3056. The following changes are being made in the specification:

1. The addition of a minimum research octane requirement of 86.

2. A change in the 50 per cent point to 239° F. maximum.

3. A change in the 90 per cent point to 356° F. maximum, in the type "A" gasolines. In addition, it is now mandatory to use a minimum of 1 lb. per 1,000 bbl. of an approved metal deactivator in both type "A" and arctic grades of gasoline.

These changes will eliminate the low-sensitivity 80-octane motor-method gasoline procured since the end of World War II in large quantities under the current specification; and the change in volatility brings type "A" military gasoline more closely in line with current commercial grades of premium gasoline.

THE AUTHOR

Col. Benjamin S. Mesick is chief of the bureau of research and materials branch, ordnance research and development division, Office of the Chief of Ordnance, Washington. Prior to entering the U. S. Military Academy in 1920, Colonel Mesick attended Cornell University, and received his D.Sc. from M.I.T. in 1938. He has had a varied list of assignments during his long military career.

This paper was presented at the A.P.I. thirtieth annual meeting Los Angeles, November 9-17.

All previous data on the use of oxidation inhibitors and metal deactivators were based on the predominantly straightrun gasolines such as were used in World War II. It will be necessary to reevaluate these characteristics in terms of the expected composition of newer fuels because some of the results may not be valid when applied to fuels which contain large percentages of thermally and catalytically cracked components.

This problem has been presented to the Motor Fuels Division of the Coordinating Research Council, Inc.; and a program is now being prepared for cooperative tests designed to provide both improved oxidation inhibitors and metal deactivators, as well as laboratory test methods, which will more accurately predict such factors as storage stability.

Although the percentage of diesel engines used in the various types of army equipment is rather small compared to gasoline engines, there are certain applications, such as construction equipment, which will continue to be diesel powered.

A great need is apparent at the present time for diesel fuels which have better low-temperature viscosity characteristics, lower pour points, and improved starting characteristics. Our investigations to date indicate that a pour point of —65° F. maximum; a viscosity of 1,000 centistokes, maximum, at —65° F.—starting at —20° F. without auxiliary starting aids— are proper goals to achieve in the near future.

The need for improvement in oxidation stability and of compatibility of diesel fuels, which is recognized as a commercial problem, will be a must for military operations.

At the present time it is not contemplated that there will be an increase in ignition-quality requirements above the present specification. We feel that the logical solution to our arctic problem may be found in fuels which fall within the range of jet fuels meeting the requirements of specification AN-F-58a.

Engine Oil

For many years heavy-duty engine oils which met the requirements of U. S. Army Specification 2-104B gave satisfactory service with the types of fuels then being used. However, it was recognized that there was a need for decreasing the wide spread in quality levels between the best and the poorest oils which met that specification. For this reason a new specification, MIL-0-2104, was issued August 4, 1950, with the intent of setting the level of quality approximately at that of the top-level 2-104B oils. That this has been successful is evident from the fact that most of the former top-quality 2-104B oils have recently been qualified under the new specification. It is felt that oils which meet the requirements of MIL-0-2104 are a definite improvement over the old 2-104B oils, and that this improvement has been obtained without materially sacrificing availability.

One change in Specification MIL-0-2104, which will be made in the very near future, it is intended to bring the viscosity requirements of the specification in line with the new proposed SAE standard. Other than this, no immediate changes in the specification are contemplated. After more experience has been obtained, other changes may be indicated.

Problems being encountered in new tank-engine designs indicate the possible need for control of the amounts of metal ash formed on combustion of these oils. Oils with sulfated residues as high as 2.0 per cent and as low as 0.24 per cent are now qualified as MIL-0-2104 oils. In some cases de-

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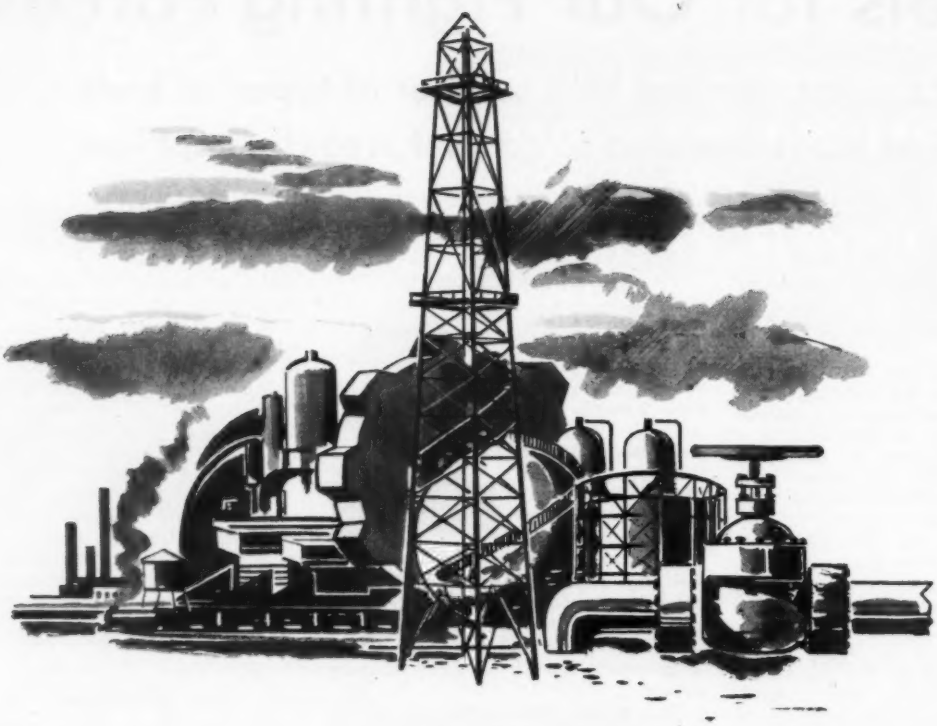

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posits have contributed to preignition in tank engines which are already operating at critical temperatures.

In the absence of any confirmed need at this time, a silver-bearing corrosion test is not being considered in the future requirements of MIL-0-2104 engine oils.

The use of MIL-0-2104 oils in transmissions will also be under very careful surveillance. Oils which contain very active sulfur caused failures in certain tank transmissions during the last war. We must be alert to this possibility again and, if necessary, place some control over sulfur content and activity in MIL-0-2104 oils.

The next item for which there is a continuing need for improvement is in subzero engine oil. During the winter of 1946-47, during maneuvers in Alaska, considerable difficulty was experienced in starting and operating military equipment at the extremely low temperatures encountered. Engine oil was one of the factors which contributed to this unsatisfactory performance, for at that time the S.A.E. 10 grade of U. S. Army Specification 2-104B type oil was the standard material for arctic use. Instructions prescribed dilution in the crankcase with 20 per cent of the gasoline at temperatures below —20° F. However, at temperatures of —30° F. and below, it was impossible to pour the oil from drums without heating the container and, in general, crankcase dilution was not properly applied in the field.

Early in 1947 the Coordinating Research Council, Inc., was requested to assist in this problem. Based on previous experience, it was decided that the development was necessary of a subzero engine oil which could be poured from a drum at —65° F., and which would permit adequate cranking speeds at that temperature.

To expedite this development, it was decided to predilute the base oil at the refinery—using a volatile solvent. With the proper selection of base stocks and 10 per cent of volatile dilution, it was possible to formulate an oil with a pour point below —65° F. and a viscosity of 10,000 seconds (Saybolt Universal) at —65° F. This oil, known as REO-15-47, was tested at Aberdeen proving ground and in the climatic hangar at Eglin Field, Florida; it was field-tested in the Alaskan theater and in convoy operation from Fairbanks, Alaska, to Detroit during the winter of 1947-48.

This oil lubricated satisfactorily most transport equipment, but oil consumption was high, and some engines were damaged considerably because the crankcase-oil level was not checked frequently enough.

Following these field tests a new oil, known as REO-28-48, was formulated with a viscosity of 10,000 seconds at —40° F., a pour point below —65° F., and which contained 5 to 8 per cent diluent. Extensive operation data and experience were obtained on this oil during the winter of 1948-49, and these helped to determine the characteristics of the present subzero engine oil.

As a result of this service information, two oils were formulated and subjected to limited service tests. One oil was a blend of a synthetic oil and a petroleum oil, and the other was a straight petroleum oil. Both oils were used without dilution, and preliminary data at low temperatures showed satisfactory lubricating properties and about the same oil consumption as a standard S.A.E. 10 grade oil.

On the basis of this experience, it was decided to use the straight petroleum oil, designated REO-72-49, for field testing during the winter of 1949-50. Results using this lubricant were generally satisfactory and, on the basis of the field-performance data, it was felt that sufficient information was available to write a specification for a subzero engine oil.

Such a specification, MIL-0-10295, was issued May 5, 1950. The characteristics of this oil are: a stable pour point of —65° F.; a maximum viscosity of 8,500 centistokes at —40° F., and a minimum viscosity of 5.75 centistokes at 210° F. Other requirements include the ability to pass satisfac-

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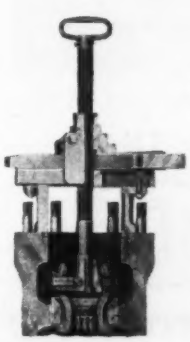

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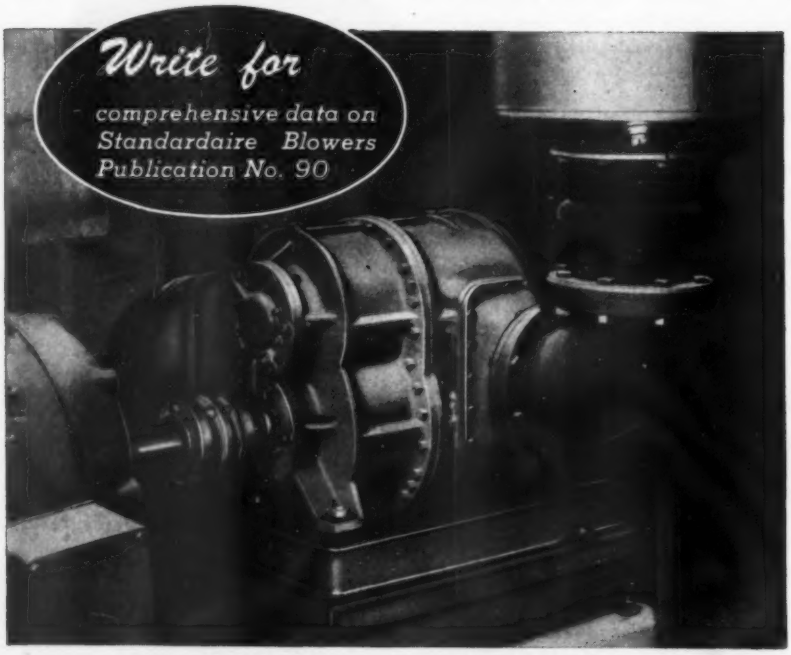

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torily the AXS-1551 and the AXS-1554 engine tests.

It should be pointed out that, to the present time, it has been difficult to produce an oil with the viscosity characteristics listed hereinbefore and at the same time to assure freedom from scratching, scuffing, and high wear rates in the engine. However, the ultimate goal in a subzero engine oil is to provide an oil which will allow cranking down to —65° F. which can be readily poured from the drums at —65° F., and which will provide engine operation with essentially the same performance as an S.A.E. 10 grade heavy-duty oil which meets the requirements of Specification MIL-0-2104.

In view of the difficulties just mentioned, it is felt that more effort needs to be expended on the development of additives which will satisfactorily prevent ring sticking, scuffing, and high rates of liner wear.

Gear Oil

At the beginning of World War II the only specification for gear oils used in army equipment was based on chemical composition. This was unduly restrictive from a procurement standpoint, and service performance was difficult to evaluate on such a basis.

In order to prepare a specification based primarily on performance requirements, an extensive program of laboratory testing and actual field-service tests was carried out with the assistance of the Coordinating Research Council, Inc. This program required almost 3 years to complete, and included more than 1,000,000 miles of road testing and about 5,000 separate laboratory tests to determine such factors as stability, foaming, corrosion, effect of high temperatures, and the effects of high speed, high torque, and shock load.

As a result of this extensive program, U. S. Army Specification 2-105B was issued in March 1946, and recently became Military Specification MIL-L-2105. This specification covers three grades of gear lubricant suitable for use over the temperature range of —40° to +125° F.

Since the issuance of the specification a number of deficiencies have been shown, and there is an apparent need for improvement of qualification-test methods.

The largest single improvement needed in gear oils at the present time is better corrosion resistance and the ability to prevent corrosion in the presence of small amounts of moisture. The work being done in cooperation with C.R.C. on a new moisture corrosion test should point the way to the development of better materials.

Lowering the operating temperature requirement from —40° to —65° F. made it necessary to develop a subzero gear oil with essentially all the required characteristics of a normal

extreme-pressure gear oil, but with much lower viscosity.

Field experience during the winter of 1946-47 revealed the 75 grade gear oil to be unsatisfactory for use in temperatures below —40° F. Gear-shifting effort became excessive when viscosity of gear oil exceeded approximately 130,000 seconds (S.U.v.). It became apparent that an arctic or subzero gear oil of considerably lower viscosity and pour point was needed.

With the assistance of C.R.C., a gear oil was formulated with the following characteristics: pour point, —65° F.; channel point, —65° F.; viscosity of 36 seconds at 210° F., and 95,000 seconds at —65° F. This oil, known as RGO-28-47, was compounded with approved 2-105B additives and a viscosity-index improver.

Ironically, although the field performance of this particular oil has been generally satisfactory, it will not pass the laboratory tests required for qualification under Military Specification MIL-L-2105. Nevertheless, based on the considerable experience which has been obtained over the past several years, a specification has been issued covering a subzero gear oil, MIL-L-10324, and covering physical requirements — but without the inclusion of specific performance tests. It is apparent that some means of evaluating gear oils of this nature must be developed in order to assure satisfactory performance of products in the field.

Greases

At the present time there are approximately nine different greases used by the army for automotive and artillery equipment. Obviously, such a large variety of materials causes considerable complication in the field from the standpoint of supply—in addition to uncertainty that individuals responsible for maintenance will always use the correct material for each application. The reasons for this situation result from limitations both in equipment design and in the knowledge of the art of grease manufacture.

In the past it has been rather common practice to manufacture a special grease for each specific application where a particular performance factor demanded a certain characteristic. In many cases the individual greases were rather inflexible in their application because of narrow usable temperature range, low storage stability, pool volatility and oxidation-stability characteristics, poor water resistance, and resistance to structural changes at high shear rates.

Experimental materials with many desirable characteristics have been service-tested for several years under a wide variety of climatical conditions, and results have been quite satisfactory. On the basis of the data available, and on the known service characteristics required, an effort is now being made to prepare a speci-

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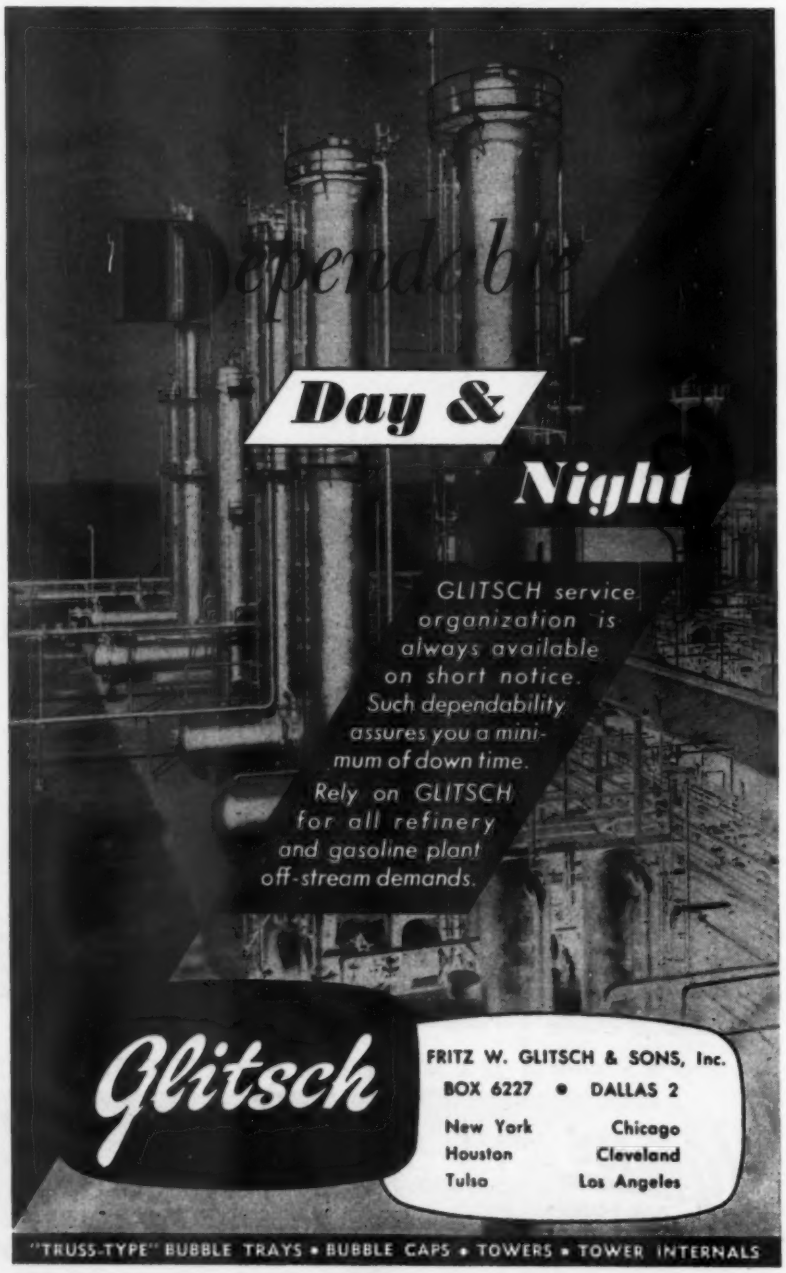
This specification will replace some five specifications in the case of the army, and the advantages to be gained from the standpoint of supply and maintenance are manifold. For example, when a change in operation takes place from a temperature to an arctic zone, the time required for complete relubrication on a medium tank is approximately 250 man-hours, and the time for a 2½-ton truck is approximately 50 man-hours. These figures are based upon ideal conditions in a well-equipped shop, but facilities for this work in the field may be quite limited, and may impose an even greater problem.

As an immediate goal, the following approximate characteristics seem desirable: dropping point, 300° F., minimum; worked penetration, 350, maximum; evaporation, 15 per cent, maximum, in 22 hours at 210° F. based on the A.S.T.M. test cell; separation, 4 per cent, maximum, in 50 hours at 160° F.; oxidation stability, a maximum of 5-psi. drop after 100 hours at 210° F. and 110-psi. initial pressure.

Other requirements will include satisfactory low-temperature characteristics, corrosion-preventive properties, water resistance, the ability satisfactorily to lubricate wheel bearings and reciprocating parts, and minimum thixotropic recovery after working.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Hydraulic Fluids

The several types of hydraulic systems presently in use in military equipment include artillery recoil systems, fire-control systems, shock absorbers, hydraulic brakes, and various power-transmission systems. In general, each system requires an independent development, and presents individual problems with respect to the working fluid. Low-temperature operational requirements reduce the number of types of usable materials, and indicate the need for a single fluid for all applications and all temperature conditions.

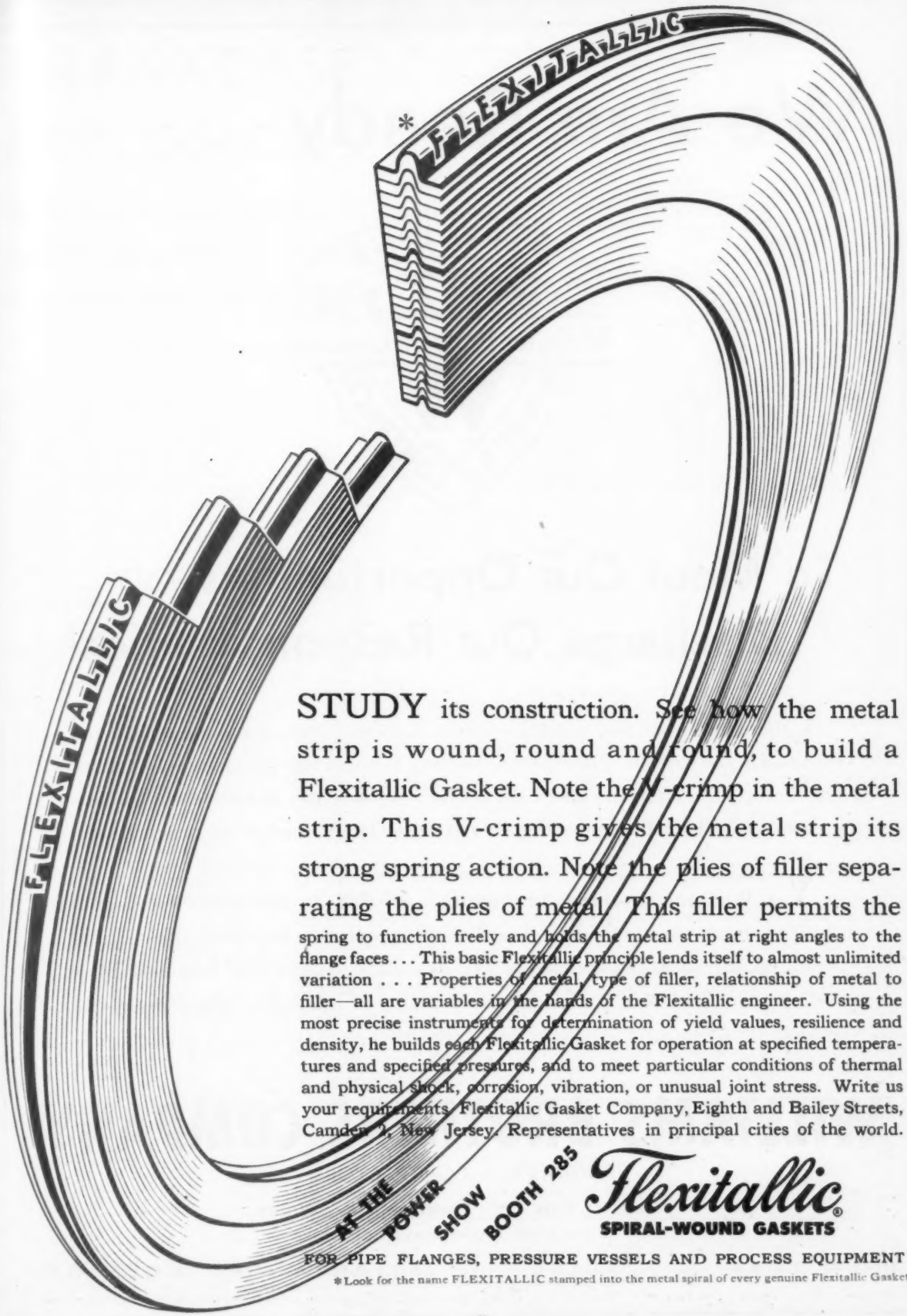
Obviously, all present devices cannot be accompanied by one hydraulic fluid because of mechanical or material limitations, but these limitations can be determined, and suitable modifications to the working fluid can be made.

At the present time there is some lack of basic data on the limiting factors in the various systems. Currently work is progressing on such factors as: permissible viscosity ranges; the effect of high shear rates; the effect on wear rate, and on corrosion inhibition; oxidation stability; and the development of compatible elastomers used for seals.

It is felt that, when more data are available on the characteristics of the many systems and on the types of materials with the desirable physical characteristics, it will be possible to formulate a single hydraulic fluid capable of universal application for the various systems in existence. As may be expected in the development of improved materials, the rate of progress is often a function of progress in the development of related equipment and materials, and cannot be increased beyond a proportionate rate.

Corrosion Preventives

There is a very great need for the development of corrosion-preventive compounds with the ability to serve as a lubricant over wide temperature ranges, capable of relatively long-term preservation, requiring a minimum of time necessary for removal and represervation, and with sufficiently high viscosity and low volatility to prevent runoff and loss at elevated temperatures. A program is now under way to develop a material along these lines for the preservation of armament for limited periods of standby storage, but to be operable without removal of the preservative. A number of proposed preservatives look promising, but more research will be necessary to determine significant factors of corrosion preventives to give the foregoing desirable characteristics.



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CRANKCASE EXPLOSIONS

Here's how a large pipe-line company approached the problem of reducing their frequency

by F. V. Cook*

CRANKCASE explosions in engines and other equipment have occurred occasionally since the first machinery was manufactured with enclosed crankcases. They have become more frequent since the crankcases of all engines have been tightly enclosed to accommodate pressure lubrication. The modern trend toward housing all auxiliary drives within the crankcase, close running fits of pistons and journals, higher operating speeds, and the use of extremely thin babbitt bearings has added possibilities of overheated surfaces. The mechanical derangement of these parts provides the heat necessary for both vaporization and ignition of the lubricating oil.

There have been few publicized reports of crankcase explosions and engine operators and builders have been reluctant to discuss them. It is the writer's opinion that if each were completely described in the trade journals and other reports a large amount of valuable information would be obtained. It is proposed in this paper only to start such a discussion by reporting the experiences of Service Pipe Line Co. and its approach to the problem.

All of the literature and discussion on crankcase explosions with which the author is familiar starts with two assumptions, viz.:

1. The oil and air mixture in an engine crankcase is normally too rich to burn.

2. Piston blowby consists primarily of the products of combustion.

It is maintained that both of these assumptions are fallacious. Explosions result from ignited mixtures of vapor and air that fill the spaces between the droplets of oily mist in crankcases; piston blowby is negligible except during the compression stroke. These are the conclusions resulting from many tests of diesel, gas, and dual-fuel engine crankcases that were made by drawing the contents of the crankcase from a shielded area to avoid including drops of lubricating oil.

All natural-gas engines the crankcases of which were vented only to the atmosphere were found to contain explosive mixtures. Diesel engines contained little or no explosive vapors even when not vented. Unvented dual-fuel engines that compress air-gas mixtures show practically no trace of combustible gas in the crankcases when burning liquid fuel.

After the gas fuel is admitted the crankcase vapors rapidly increase in gas content to approximately the same mixture that is being burned. By connecting the crankcase to the engine air intake and opening a vent

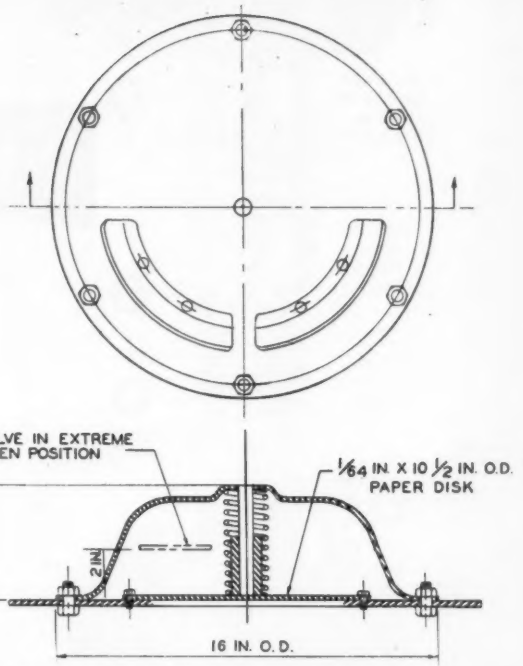


Fig. 1—Construction details of an explosion relief valve for engine crankcase.

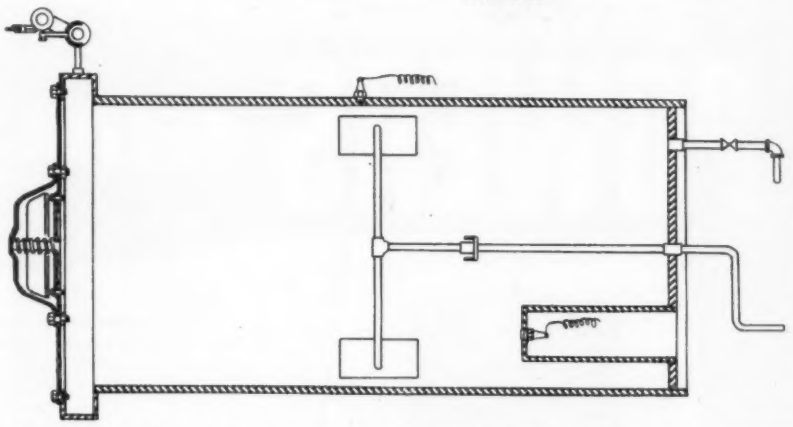


Fig. 2—Sectional drawing of apparatus used for testing relief valves. Explosion chamber volume 25 cu. ft.

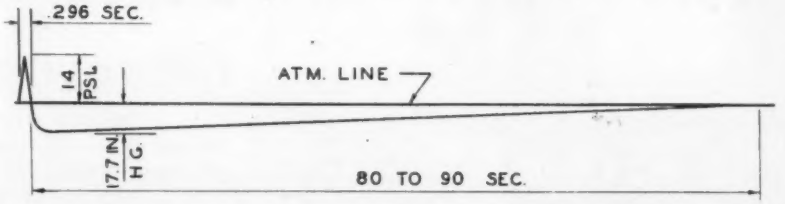
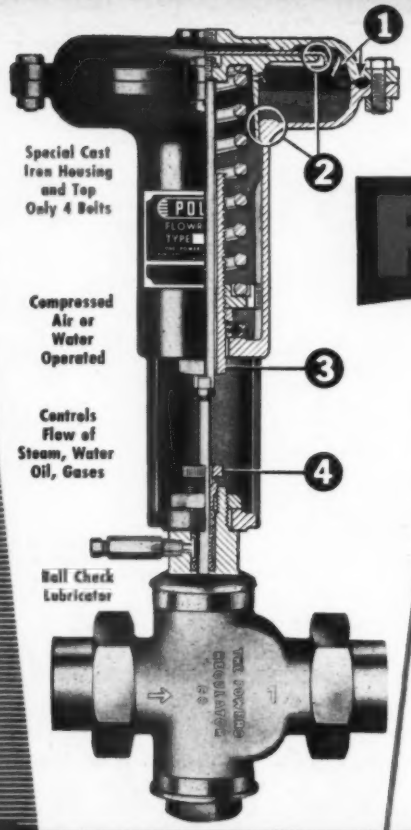


Fig. 3—Pressure time curve obtained by exploding an air-gas mixture in the test tank.

*Master mechanic, Service Pipe Line Co. Paper presented at American Petroleum Institute meeting of Subcommittee on Products Pipe-Line Technology, St. Louis, September 1950.



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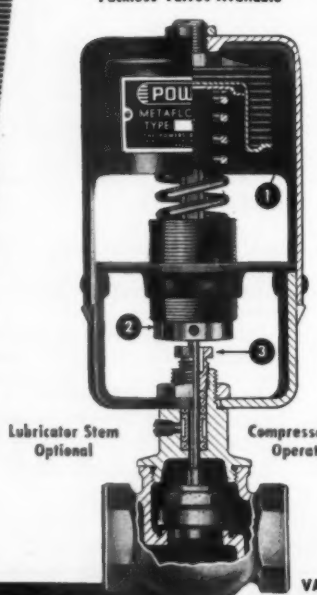

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in the opposite end, this gas-air mixture can rapidly be displaced with air. These tests, performed many times, can lead only to the conclusion that there is sufficient blowby on the compression stroke of every engine to place in the crankcase the same mixture that is being compressed by the piston.

No appreciable quantities of carbon monoxide or carbon dioxide have been found in the crankcases of diesel or gas engines, even when the piston rings were in poor condition. In groping for an explanation, the writer remembers slow-speed engines blowing by the rings in which the sound of the leakage practically stopped at the end of the compression stroke. Another possible reason is the distance of the ring belt from the start of combustion. If the engine is burning all of its fuel, the excess air occupies the space adjacent to the rings because it is farthest from the start of combustion. It is hoped that these statements will prompt laboratory tests by some of the engine builders which will prove or disprove the suppositions.

Dual-Fuel-Engine Explosions

Service Pipe Line Co. experienced two serious crankcase explosions on new dual-fuel engines soon after they were placed in service during the latter part of 1948. We have experienced another, on an older engine, since the first of this year. The first and second explosions resulted from hot auxiliary drive bearings in the front end of new seven-cylinder, 1,600 hp. engines.

The first explosion, occurring while the engine was operating on liquid fuel, blew off two thin sheet-steel doors and set the engine crankcase afire. Damage to the building was slight.

The second explosion occurred while operating on both liquid and gas fuel, and blasted all but one door from the engine crankcase and also set the crankcase afire. Damage to the building was extensive. Many windows were broken and the Transite roof was so badly damaged that replacement was necessary. A wooden partition, placed in the end of the building in preparation for removing the end wall, was blown out.

The most recent explosion resulted from hot main and crank bearings in a six-cylinder, 500-hp. engine that had been converted to dual fuel. This explosion caused slight damage to the building and no damage to the engine except breakage of one of the cast-iron crankcase doors. It was not followed by fire. We were extremely fortunate that no one was injured because any of the explosions could have been fatal had an employe been in the path of the doors that were blown from the engines.

Serious burns could have resulted from being close to the engines at the time of the explosions. Secondary, more violent, crankcase explosions are usually reported in papers on this subject. All of the explosions described here were witnessed by operating personnel but there was no evidence of secondary explosions in these instances.

Both 1,600-hp. engines were vented at the front end through 2-in. line and an Air-Maze separator to the engine air intake, but the crankcase was not open for air inlet except for leakage and via the front-end lubricating-oil return line to the open lubricating-oil sump tank. Thus, practically all air passing through the crankcases was passing the bearings that caused the explosions.

Subsequent tests, under identical operating conditions, proved that the crankcases were practically free of combustible vapors in the front end before the bearings heated and vaporized lubricating oil, but contained increasing amounts of combustible vapor toward the flywheel end, farthest from the vent, until the mixture stabilized at approximately the same ratio that was being compressed by the pistons.

The 500-hp. engine was fitted with a similar separator and a ¾-in. vent line. The separator was stopped up and there was no opening in the crankcase to admit air, so for all

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practical purposes the engine had no vent, although the separator would not hold measurable pressure in the crankcase.

All of these engines have been provided with forced ventilation by connecting the crankcase to the air intake and opening the opposite end of the crankcase to admit air. We are not certain that this is the proper procedure because explosions are more frequent in diesel than in spark-ignited gas engines, and most of the latter carry explosive mixtures in the crankcase. This may possibly be explained by assuming that the mixture becomes too rich to detonate soon after mechanical derangements start adding lubricating-oil vapors to the gas-air mixture. The higher temperature required to ignite methane mixtures may also be a partial explanation (petroleum vapors, approximately 1,000° F.; methane vapors, approximately 1,500° F.).

Preventive Measures

A study of preventive measures suggests:

1. Maintain a nonexplosive mixture in the crankcase. One method of doing this would be to pass natural gas through the crankcase to the engine intake. (This has not been seriously considered because of the hazard of explosive mixtures each time the crankcase was opened.)

2. Provide means of drenching the crankcase with carbon dioxide when trouble occurs. (This idea was abandoned because of the high cost and the fact that it would seldom be used when needed. Vapor detector equipment is high priced, also, and not reliable for continuous use in such a large area.)

3. Strengthen the crankcase to withstand an explosion. (This could not be seriously considered on our engines, many of which are 30 years old. It should be considered for new engines, especially in the smaller sizes.)

4. Remove from the crankcase, insofar as possible, all sources of hot surfaces. (This, again, would not be practicable in old engines but should be considered in the purchase of new engines. Tin-plated pistons, as an example, go far to remove a source of hot surfaces.)

5. Realize that explosions are unavoidable and provide a sufficient quantity of explosion valves to relieve the pressure without damage to property or personnel and to prevent the fire that often follows crankcase explosions.

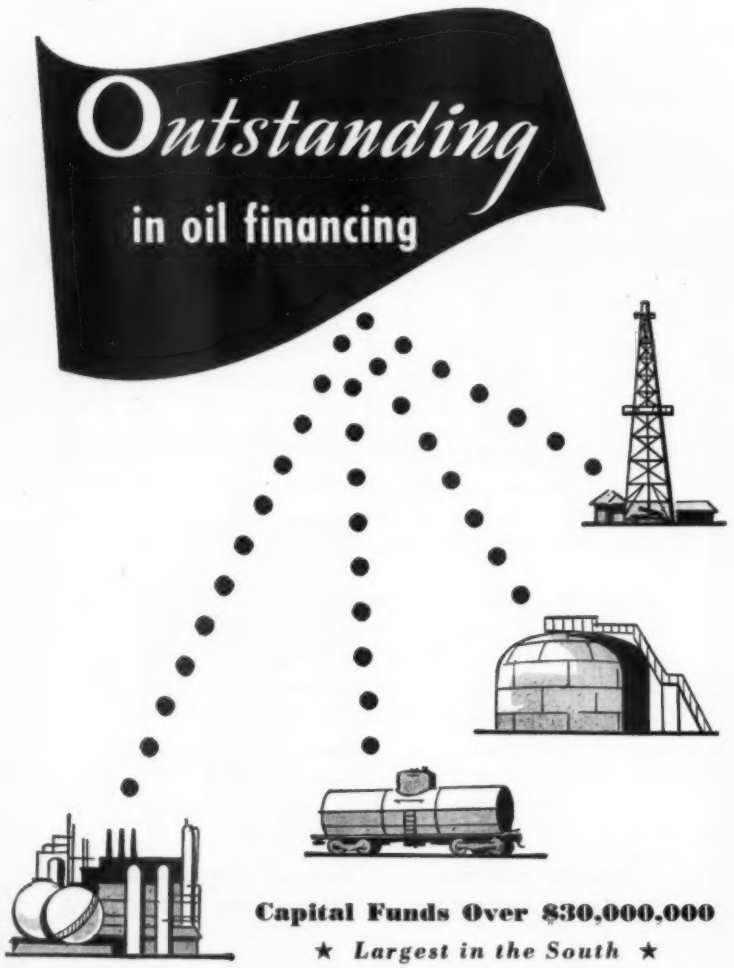
Service Pipe Line Co. decided on the last-mentioned course, and an investigation of explosion valves available from the engine manufacturers developed that most were designed for high pressures and the costs were high. We believed that explosion valves for our old engines should open at low pressures to obviate expensive replacement of doors and covers.

Avoiding High Pressures

To avoid high pressures we decided to provide more relief area than the ½ sq. in. for each cubic foot of crankcase volume recommended by the Diesel Engine Manufacturers Association. We proceeded, accordingly, with the design of the largest valve that could be applied to the smaller crankcase doors with the idea of placing one on each door.

A general outline of the explosion relief valve selected is shown in Fig. 1. Two of these valves will be placed on each crankcase door of some of the large engines. Twelve hundred explosion valves will be required to equip all of our engines and several pumps. Reports of crankcase explosions that have broken doors without rupturing paper blowout diaphragms prompt placing valves on all crankcase doors. The Bureau of Mines' demonstration of the behavior of explosions in glass tubes with paper-covered outlets is additional justification for installing as many explosion relief valves as practical.

Explosion relief valves received with new engines leaked oil when designed to open at 5 psi. pressure and to be fully open at 15 psi. pressure, so we decided that the valve must cover a blowout gasket that would serve as an oil seal. It has been possible to purchase valves as shown in Fig. 1 for $10 each and to install them economically on our flat steel doors. In some cases it was



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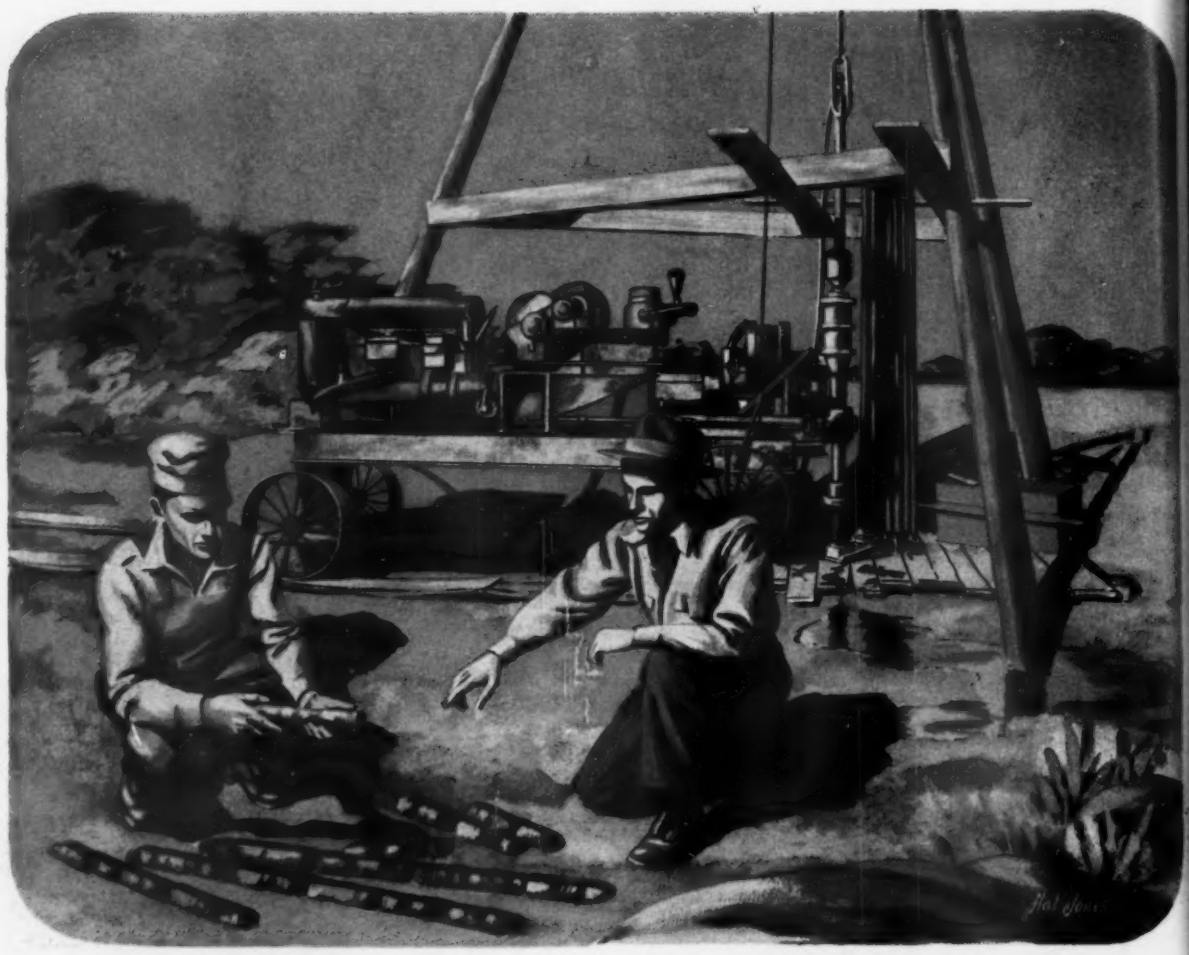

CHAPTER FIVE in the Fascinating Story of the Search for Oil

In 1922 Core drilling for structure was suggested by Burton as early as 1917 and was introduced into Oklahoma in 1919 simultaneously by Dr. W. A. J. M. van der Gracht, who had used the diamond drill with great success in Holland, 1905-1915, and who had used it in structural determination in Roumania before 1914, and by M. M. Travis, formerly of the Midco Petroleum Company. Its initial and a very important success was that of outlining the north extension and limits of the Tonkawa, Oklahoma pool in 1922. Core drilling continued at a very active rate in Oklahoma until it was superseded by the reflection seismograph and continued to be used in Western Kansas for the determination of structure of such slight degree that it was within the limits of error of the seismograph (as used at that time). From E. DeGolyer's book, *"The Development of the Art of Prospecting."*

In 1950 In order to push the search for new oil reserves into previously inaccessible areas and to work under adverse climatic conditions, General Geophysical crews today also have completely portable, climate-proofed seismograph equipment at their command. Developed in General laboratories, this completely unitized, air-craft type construction equipment adds new strength, portability, convenience and dependability to seismograph operations. General's portable seismograph equipment was designed specifically to provide trouble-free service under all adverse conditions encountered in marsh, swamp, arctic and foreign countries without sacrificing the standards of performance characteristic of other General instruments. And General promises further progress in the future in the search for oil reserves

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found less expensive to make new flat steel doors than to fit the valve to cast-iron doors. It is suggested to the engine builders that this would be an excellent time to standardize at least one part for all diesel engines. In our opinion, these valves are less expensive and more satisfactory than any that they have designed.

We have tested one of these valves by exploding natural gas in a 25-cu. ft. tank. The test apparatus is illustrated by Fig. 2. The explosion relief valve was tested by attaching it to a ⅞-in. thick by 26-in. square steel plate, and later to a ¼-in.-thick aluminum plate of the same size to simulate our weakest crankcase doors.

Fig. 3 is a facsimile of a typical pressure-indicator card obtained while testing a 16 : 1 air-gas mixture. For purposes of illustration, the abscissa, representing time, has not been transposed to scale. The significance of the pressure-time diagram is that the maximum explosive pressure of 14 psi. was reached in approximately .15 second and as rapidly returned to zero, after which time the ungasketed relief valve closed and then held a vacuum in the tank for 80 to 90 seconds. The illustration shows how adequately the valve relieved the pressure of the explosion, yet closed rapidly enough to prevent entrance of fresh air which could sustain a secondary explosion.

During other tests we were able, by varying the mixture and agitation, to obtain maximum pressures of 20 psi. With the relief valve removed and only a 1/64-in.-thick by 10½-in. diameter paper gasket used to seal the tank, the maximum pressures decreased by about 20 per cent but the safety feature of the reseating valve was lost.

A final test was made using a solid steel plate in place of the paper gasket. Under this condition the maximum pressure was 80 psi. which was relieved by leakage at the door gasket. The center of the ¼-in.-thick aluminum door bulged outward about 5 in. and took a permanent set of about 2 in. Had the door been made of cast iron it doubtless would have shattered.

The maximum pressure resulting from an explosion of crankcase vapors and air at standard atmospheric conditions is approximately 100 psi. It would be possible, even on large engines, to build the crankcase to withstand this pressure but the added expense would extend to strengthening exterior parts such as lubricating-oil sumps. We believe the practical solution to crankcase explosions remains with appropriate relief valves.

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Optimum Use of

Coring, Electric Logging, and Other Testing Methods in Exploratory Wells

by John E. Walstrom

The principal results of this analysis are shown in the form of three exploratory-drilling-program charts, classified on basis of the formation-evaluation methods used

ONE of the most critical and difficult technical problems challenging those who are concerned with exploratory drilling operations is the correct evaluation of the fluid content of the drilled formations. Very important responsibility is associated with this phase of exploration because a wrong decision may forfeit not only the production from a single well, but from an entire oil field.

The development of equipment for sampling and testing formations began about 30 years ago. Since that time, several special tools and logging methods have been evolved to assist in the search for oil and gas. During the earlier stages of development of these pools, the desirability of using one in preference to another was often debated. One concept was that the electric log soon would replace the core barrel. However, it is now quite well established that the various testing and logging methods furnish different types of information; that they have their respective advantages; and that they function best when used in a complementary manner in a planned program of exploration.

The present study is an analysis of the various methods by which the formations encountered in exploratory drilling may be evaluated through a coordinated use of the several sampling, testing, and logging techniques. First, the individual techniques are reviewed briefly and then their coordinated use in exploratory drilling is analyzed. In reviewing the techniques emphasis is placed on their advantages and disadvantages. A discussion of the principles fundamental to the mode of operation of the various methods has been omitted purposely, since such information may be found in the numerous references provided. The principal results of this analysis are presented in the form of three exploratory drilling program charts, classified on the basis of the formation evaluation methods that are used.

Review of Methods

Coring.—It is claimed that the first rotary core bit was made in 1863 by Leschat, a French engineer. No important improvements in this tool took place until about 1916, when core bits were introduced commercially in the oil fields. The general use of coring equipment began about 1923.[1]

The great advantage of coring is that a core is the direct physical evidence of the type of strata being penetrated by the bit and furnishes qualitative information concerning the formation fluids. If the core has the qualities of a possible reservoir rock, it often is subjected to a detailed laboratory examination which furnishes data on the porosity, permeability, formation factor, and interstitial water saturation.[2,3] These data describe the solid structure of the core at the temperature and pressure at which the measurements are made.

Core analysis also provides measurements of the residual oil, water, and gas that remain in the core after withdrawal from the hole. The latter values, however, are not representative of the conditions in the reservoir prior to penetration by the coring bit. Cores may also be taken for paleontological or other geological determinations. The importance of core analysis to an understanding of reservoir performance was recognized very early.[4,5]

A significant disadvantage of coring, in an exploratory operation, is the inability to determine when to core since it is generally not economical to core at closely spaced intervals. A core may be taken on the basis of a ditch or mud-logging show; but where sands are thin even this may be too late to obtain a sample of the oil-bearing rock. Other shortcomings of coring are its relatively high cost in comparison with some of the other formation-evaluation techniques, lost recovery, and the slower rate of penetration when coring most formations as compared with drilling.

It is often stated that one advantage of coring and core analysis is that these methods assist in the interpretation of the electric log. This is particularly true in a proven field where coring and core analysis if employed in a few strategically selected wells will materially aid in the interpretation of logs made in the many wells that are not cored. However, in an exploratory well, the value of this collaboration of techniques is not as great, since, if the core is taken, the presence of oil in the formation is usually determined by the core itself.

Formation testing.—Formation testing equipment was developed in the Mid-Continent and has been used

THE AUTHOR

John E. Walstrom is well-logging consultant for Standard Oil Co. of California, at San Francisco. He was graduated from University of New Hampshire in 1932, and received his M.S. degree in physics at Cal Tech, and in 1936 became associated with Schlumberger Well Surveying Corp., with which firm he spent 10 years in California and Texas as an engineer. He has been engaged in his present work since 1947.

Paper presented at A.P.I. thirtieth annual meeting, Los Angeles, November 9-17.

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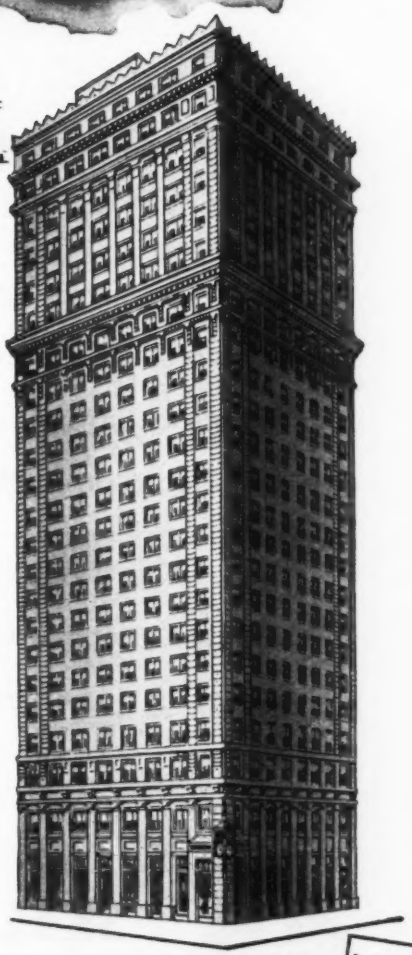

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commercially there since about 1926. However, formation-testing patents date back to approximately 1870. The formation tester was introduced into California about 1930.[6]

From one very important standpoint, formation testing, or drill-stem testing as it is sometimes called, is superior to other formation-evaluation methods in that it brings into play the dynamic forces within the reservoir. It is probably the most diagnostic test of the ability of the reservoir to produce, and the nature of this production. Formation tests may be made in open hole, using various types of packers; in stub liner, or a full string of casing through slots or gun perforations. Obviously, a test made inside a full string of casing is practically equivalent to placing the well on production. Thus, the diagnostic efficiency of a formation test varies greatly, depending upon the way the test is made, the equipment used, and on the length of time the test is continued.

The interpretation of the results of a formation test is often difficult and requires careful consideration of the many factors involved. The disadvantages of formation testing are: (1) the possibility of losing the hole while testing, and (2) the possibility of a misleading test due to a water sand masking the presence of an oil sand when both are exposed in the test interval; or due to low formation pressure in which case sufficient fluid may not enter the tester to be representative of the formation tested.

Side-wall sampling. — Devices for side-wall sampling were first used in the late twenties[7] but did not attain a general use until the mid-thirties, when the development of electric logging made possible an optimum cooperative functioning of the two methods.

Side-wall-sampling tools are run either on drill pipe with a wire-line removable core barrel,[8 9] or on an insulated multiconductor cable,[10 11] such as used for electric logging. Samples may be punched or actually cored from the wall of the hole by either the type of sampler run on drill pipe, or the type run on logging cable. The samples taken with drill pipe require more rig time but are larger than those obtained on logging cable equipment. Since the electric log is not obtained concurrently with drilling, possible oil or gas-productive formations are often revealed that were not tested or cored. In such instances, the side-wall-sampling technique may be of great assistance.

The particular type of side-wall sampler chosen depends on the type of formations, number of samples required, and the purpose for which the samples are obtained. The outstanding advantage of side-wall sampling is that the samples usually may be obtained at minimum cost and at any preselected position in the hole after the electric log has been run which is in direct contrast to conventional or wire line coring. In general, side-wall samplers are employed most advantageously immediately after running the electric log.

Four disadvantages of side-wall sampling are: (1) The flushing action of the drilling fluid often reduces the diagnostic value of the measured fluid saturations to a minimum. (2) It is difficult to obtain dependable core-analysis results on side-wall samples. (3) The samples are of questionable value when taken in a hole drilled with a fluid containing oil. (4) It is difficult to obtain adequate samples if a thick mud cake has formed.

Electric logging. — Electric logging was developed commercially in 1928[12] and was introduced into the United States in 1932.[13]

The advantages of electric logging are: (1) It furnishes a continuous record along the entire open hole. (2) It is relatively inexpensive, as compared with coring and testing an equivalent interval. (3) It requires only a few hours rig time per survey. (4) It ordinarily does not endanger the hole. (5) Whereas core analysis data, such as permeability values, vary statistically over a wide range partly due to the small samples on which measurements are made, the electric log values are the result of measurements made on very large samples of formation more representative of the macroscopic quality of the reservoir. This is an advantage of the electric log other than in thin laminated formations where it is a disadvantage.

Correlation of the available electric logs in any area furnishes much struc-

Chart 1—Testing On Way In

Variations of general program on basis of the number of techniques used for formation evaluation:

Plan A—

1. Install complete mud-logging or cuttings-analysis service.
2. Obtain ditch samples for paleontological determinations.
3. Drill ahead and core if:
(a) significant oil shows;
(b) drilling breaks near objective interval.
4. Run electric log.
5. Side-wall sample as necessary.
6. Formation test as indicated.

Plan B—

1. Drill ahead and core if:
(a) significant oil shows on ditch;
(b) drilling breaks near objective interval.
2. Obtain ditch samples for paleontological determinations.
3. Run electric log.
4. Side-wall sample as necessary.
5. Formation test as indicated.

Plan C—

1. Drill ahead without coring.
2. Obtain ditch samples for paleontological determinations.
3. Run electric log.
4. Side-wall sample as necessary.
5. Formation test as indicated.

Variations of procedure on basis of drilling practices:

Plans A, B—

1. Coring may be done in reduced hole or full hole.
2. Side-wall samples may be obtained on logging cable or drill pipe and may be cored or punched depending on the type of formation. (This also applies to 1-C.)
3. Formation tests may be obtained using a shoulder or side-wall packer tool. (This may also apply to 1-C.)

Plan C—

1. Drilling may be in 500-1,000-ft. stages of reduced hole followed by running electric log, then reaming and testing any favorable intervals on basis of log or ditch shows. This method may necessitate plugging.
2. Drilling may be in full hole, reducing hole on a significant ditch show or drilling break.

General advantages for Plans A, B, C—

1. Bottom-hole tests in open hole on the way in are often more representative of true formation fluid because:
(a) Minimum contamination of formations by drilling fluid, filtrate, or cement.
(b) The possibility of a failure of the cement bonds behind the casing is avoided.
(c) The possibility of a plug leaking, or the tool slipping off a plug, when testing in open hole on the way out are avoided. (1-C, however, may require plugging.)
2. Bottom hole tests of intervals of 100 to 300 ft. on the way in are often considerably less expensive than testing equivalent intervals inside casing on the way out and particularly so if water shut-offs are obtained above and below the interval to be tested.
3. More assurance of evaluating the shallower formations, since, if the well is not tested on the way in and is completed successfully in a deep objective, the shallower tests are very seldom made until the well becomes uneconomic, or must be made in another well.
4. Casing and cementing costs have not been incurred before the evidence of production is established.

General disadvantages for Plans A, B, C—

1. More time is required to reach the deepest lying objective than when testing on the way out.
2. More danger of losing the hole or fishing before reaching total depth than when testing on the way out. This may require sidetracking and redrilling before the lowermost objective can be evaluated.
3. Tests cannot always be made in the desirable intervals. Better control of the interval to be tested is obtained by selective gun perforating.
4. Formation tests are usually limited to short duration due to danger of sticking tool. Testing inside casing allows swabbing or bailing and making a production test with considerably less danger.
5. In some areas, open hole testing may be dangerous below a certain depth due to sticking of the packer.
6. When drilling is rapid and the sands are thin, the bit may pass through the showings before the hole size is reduced. This would preclude the use of a shoulder type packer.

Applications for Plans A, B, C—

1. The general procedure of testing on the way in is best applied to wells drilled in highly unevaluated areas where several formations may prove to be of commercial value.
2. This general type of program is also adapted to wells of the semiexploratory nature drilled on the edge or near oil fields in which several commercial formations are known to be present.

tural information. The electric log also is used for locating water, obtaining a sand count,[14 33] estimating the relative fluid content,[16 17 36] determining optimum points at which to set the casing or a formation tester packer, and evaluating the magnitude of reserves.

The electric log has three significant disadvantages: (1) A high value of apparent resistivity on the long electrode spacing resistivity curves may be due not only to the presence of hydrocarbons; but may be caused by fresh or brackish interstitial water, a relatively nonporous formation, or an interval seriously invaded by drilling fluid and drilling fluid filtrate.

In operations of an exploratory nature, it sometimes is difficult to tell which of the above factors is responsible for the favorable appearance of the log. In difficult cases, the use of several spacings and special interpretive methods often will help. (2) The electric log is not obtained concurrently with the progress of the drill bit. This is in contrast to coring and cuttings analysis the results of which are obtained almost concurrently with the progress of the drill bit, thus allowing testing at the most opportune time and in the most opportune manner. (3) It should be pointed out that the diagnostic ability of the electric log is greatest in reservoirs having a granular type of porosity as exhibited by sandstones. An accurate analysis of electric logs made in fractured reservoirs, in which the fluid exists in cracks and fissures is often difficult or impossible.

It is interesting to note that although coring and testing give results directly in terms of fluid content and rock type, the electric log and radioactivity logs yield information concerning the electrical and radioactive characteristics of the formations. These characteristics must then be translated into values in terms of the physical entities, porosity, permeability, and fluid saturations. Since the electrical and radioactive characteristics of the formations usually involve the physical ones in a rather complex manner, the problem is difficult and often the solution is only an approximate one.

The several curves of the electric log may be regarded as a set of equations in which there are more unknown variables than there are equations. If the resistivity of the formation interstitial water and the formation factor are known or may be estimated, the diagnostic value of the electric log is enhanced considerably.[35] The effect of the presence of the mud column and invaded zone,[19] and the thickness of the sedimentary layers,[29] must also be taken into account when interpreting an electric log.

Drilling-fluid and cuttings analysis. These methods,[20 21 22] of formation

Chart 2—Testing On Way Out In Open Hole

Variations of general program on basis of the number of techniques used for formation evaluation:

Plan A—
Same as Chart 1, Plan A, except omit Item 6.

Plan B—
Same as Chart 1, Plan B, except omit Item 5.

Plan C—
Same as Chart 1, Plan C, except omit Item 5.

Variations of procedure on basis of drilling practices for Plans A, B, C—

1. Coring and drilling are done in full hole since no formation tests are made on the way in.
2. Side-wall samples may be obtained on logging cable or drill pipe and may be cored or punched depending on the type of formation.
3. Formation tests are made on the way out using a side-wall packer.
4. A caliper survey is required for determining the proper position of the side-wall packer. It is ordinarily run after the last electric log survey.

General advantages for Plans A, B, C—

1. Casing and cementing costs have not been incurred before the evidence of production is established.
2. The total depth of the well is reached more quickly and economically than when testing on the way in. Thus, if the deepest objective is commercial, an economical well can be completed at a minimum cost.
3. There is less danger of losing the hole before total depth is reached than when testing on the way in.
4. If the hole is lost while testing on the way out, the objective sands lying at maximum depth have already been evaluated. In this case it may be desirable to abandon the hole. However, if the hole is lost while testing on the way in, it is necessary to redrill before evaluating the deepest objectives.
5. Testing on the way out eliminates the necessity of drilling in reduced hole on the way in.

General disadvantages for Plans A, B, C—

1. Tests may be uncertain because the formations are exposed to mud, filtrate, and cement for longer periods than when testing on the way in.
2. Testing in full hole on the way out is not as definitive as bottom hole testing on the way in, since the cement plug can leak or slide down the hole, or the tail pipe can slip off the plug.
3. Open hole testing is not as safe as testing inside casing.
4. Placing cement bridges contaminates the mud increasing the cost of mud treatment.
5. In some areas open hole testing may be dangerous below a certain depth due to sticking of the packer.
6. If deepest objective is commercial, shallower formations remain unevaluated since further testing is often dispensed with.
7. Testing in open hole on the way out may be impossible due to caving or washing out of the formations preventing the packer from holding.

Applications for Plans A, B, C—

1. Testing on the way out in open hole is applicable to exploratory wells in which a deeper objective is found to be nonproductive or absent, and in which shallower formations, although previously believed to be not as attractive, have given some evidence of possible oil or gas accumulation.

Chart 3—Testing On Way Out Inside Casing

Variations of general program on basis of the number of techniques used for formation evaluation:

Plan A—
Same as Chart 1, Plan A.

Plan B—
Same as Chart 1, Plan B, except omit Item 5.

Plan C—
Same as Chart 1, Plan C, except omit Item 5.

Variations of procedure on basis of drilling practices for Plans A, B, C—

1. Coring and drilling are done in full hole since no formation tests are made on the way in.
2. Side-wall samples may be obtained on logging cable or drill pipe and may be cored or punched depending on the type of formation.
3. Formation tests are made on the way out by selective gun perforating after cementing pipe. It is considered good practice to obtain water shutoffs above and below each interval to be tested.

General advantages for Plans A, B, C—

1. Can swab or bail and make a definitive production test of an interval which in some cases may be more representative of the formation fluid content.
2. The total depth of the well is reached more quickly and economically than when testing on the way in. Thus, if the deepest objective is commercial, an economical well can be completed at a minimum cost.
3. If the hole is lost while testing on the way out the objective sands lying at maximum depth have already been evaluated. In this case it may be desirable to abandon the hole. On the other hand, if testing on the way in, it would be necessary to recover the fish or redrill before evaluating the deepest objective.
4. Less probability of sticking packer inside casing than in open hole.
5. Can test a very long section of several hundred feet at one time if necessary.
6. Intervals to be tested can be selected as desired on basis of electric log.
7. There is less danger of losing the hole before total depth is reached than when testing on the way in.
8. Testing on the way out eliminates the necessity of drilling in reduced hole on the way in.

General disadvantages for Plans A, B, C—

1. Tests may be uncertain because the formations are exposed to mud, filtrate and cement for longer periods than when testing on the way in.
2. Casing and cementing costs incurred before production is evidenced.
3. Testing an interval of less than 200 ft. inside casing on the way out is usually more expensive than testing the equivalent interval in open hole on the way down.
4. Considerable difficulty may be encountered when testing or completing in an unconsolidated sand through gun perforations due to sand trouble.
5. Difficulty of establishing water shutoffs is sometimes considerable.
6. If deepest objective is commercial, shallower formations remain unevaluated since further testing may often be dispensed with.

Applications for Plans A, B, C—

1. Exploration at depths considered unsafe for the open hole type of tester. See text.
2. Salvage in shallow sands after setting pipe for a deep objective which proves to be noncommercial.
3. Exploration in interbedded oil sands and wet sands.
4. Shallow exploration with multiple objectives where cost of pipe may not exceed cost of several tests.
5. Exploration in areas in which the electric log is diagnostic of the fluid content.

evaluation often are referred to, either individually or together, as "formation logging," "mud-analysis logging" or merely "mud logging" and have been offered commercially since 1939.[20] The three outstanding advantages of this method are: (1) No extra rig time is necessary in order to collect the data. (2) The data are obtained almost concurrently with the progress of the drill bit, which usually allows coring and testing any show that is obtained. (3) Much unnecessary and blind coring is often eliminated.

Disadvantages of this technique are: (1) The oil and gas shows are of a qualitative nature. (2) Due to the necessity of constant supervision by skilled personnel, the service may be relatively expensive if drilling progress is slow. (3) The diagnostic effectiveness of mud logging is greatly reduced or nullified when a drilling fluid containing oil is used, and is also reduced in areas where many noncommercial accumulations of hydrocarbons exist.

Gamma-ray logging.—The method measures the naturally existing gamma-radioactivity of the formations. Shales ordinarily show a higher radioactivity than sands and thus often may be delineated from the latter by means of a gamma-ray log.[23] Gamma-ray logging[24] was placed on a commercial basis in 1940.[25]

The advantage of the gamma-ray logging method is that it may be employed profitably in cased wells that were drilled and completed before the advent of electric logging. Since the gamma radiation penetrates the casing readily, a log may be obtained inside the casing showing the positions of the sands and shales. Such a log is of great advantage if it becomes desirable to enter an old well in order to perforate cased-off formations which have later been proven to be oil or gas bearing.

The gamma-ray log frequently is run inside casing or liner in conjunction with a collar locator as one of the methods used to insure accurate gun perforating when testing or completing under conditions in which the ordinary accuracy of measurements would not be suitable. Gamma-ray logging may also be employed in holes that are empty or those that are filled with an insulating fluid, such as oil or oil-base fluid, either of which preclude the use of the conventional electric-logging equipment. The gamma-ray method may be used in holes drilled with salt water since such conditions also do not lend themselves well to the electric logging method.

In the above applications, the gamma-ray curve is used as a correlation tool since it determines the geometry of sand-shale sequence. Its ability to function in this manner depends upon the contrast in intensity of natural radioactivity of the sands and the shales. The contrast in radioactivity of the sediments varies considerably from one general area to another. As a result, the success of the gamma-ray log, as a correlation tool, must be established by trial in any particular field.

Neutron logging.—The neutron log has been available commercially since 1941.[27] This radioactivity well logging method usually is used in a complementary manner with the gamma-ray log; similar in some respects to the cooperative functioning of the potential and resistivity curves of the electric log.

Whereas the gamma-ray curve is used principally as a correlative tool to delineate sands from shales, the neutron log is influenced more by the fluid content of these formations. The neutron log has been used successfully to detect the presence of dry gas, and is also used to locate the fluid bearing zones in a generally dense limestone section. These two uses of the neutron log depend on the absence and presence of fluid, respectively. The ability of the neutron curve to detect fluid is a result of the interaction of the neutrons with the hydrogen nuclei present in the formations. Since both oil and water are hydrogenous, the neutron method is incapable of distinguishing between the two.

A new neutron technique has recently been developed[28] and is being offered commercially. This technique utilizes a detector which is sensitive to the scattered slow neutron flux rather than to the secondary gamma-radiation caused by the neutron bombardment. The advantages and disadvantages of this new technique remain to be evaluated.

Since the neutron curve is an indicator of fluid, it will likewise be an indicator of porosity in formations in which the pore space is entirely filled with oil, water, or a combination of the two. Such a relationship between porosity and the neutron curve has been developed for limestone formations and is discussed in the literature.[29,30]

Induction logging.—The principal use of the induction logging method is to obtain a resistivity log in holes drilled with oil or oil-base fluid without forcibly contacting the walls of the hole. The induction log[31] was introduced on a commercial basis in 1947. The highly insulating nature of these fluids preclude the use of conventional electric logging equipment.

An alternative method that is also used for logging in oil or oil-base fluid is an electric-logging system utilizing wire brushes that scratch the walls of the hole, making contact with the formations. The latter method has the disadvantage that the brushes sometimes make erratic and poor contact with the walls of the hole, which introduces spurious resistance in the circuits and impairs the quality of the curve. The use of forced contact with the walls is also more likely to result in sticking of the tool in the hole. Frequently the induction log and the "scratcher" log are both employed when logging a hole drilled with oil-base fluid or oil.

Both radioactivity logging and electric logging provide two types of curves. The gamma-ray curve of the radioactivity log and the potential curve of the electric log show the position of the various sands and shales penetrated by a well bore. They are essentially correlation curves. The neutron curve and the resistivity curves, on the other hand, are used primarily to study the fluid content of the formations.

If oil-base fluid has been used in the drilling of the hole and if the invaded zone is sufficiently small, the investigative radius of the induction logging system is sufficient to reach behind the invaded zone. Under these conditions, the induction log may be used to study the fluid content of the formations. The correlation curve in this instance may be either a gamma-ray curve or a single-electrode-scratcher curve.

It is important to point out some of the advantages inherent in the use of the induction log in oil-base fluid. The standard type of electric log made in water-base fluid is affected by the presence of the mud column, the presence of an invaded zone, and the presence of neighboring formations that may be included in the region of investigation. However, with induction logging: (1) The effect of the fluid column is minimized since the oil-base fluid is highly resistive; (2) the effect of the invaded zone is minimized due to the low filter loss of the oil-base drilling fluid; (3) due to the small invaded zone with oil-base drilling fluid, the proximity effect of nearby formations is reduced since a sufficient radius of investigation may be obtained with a relatively small spacing.

The above discussion indicates that a low-filter-loss, electrically insulating drilling fluid, has some inherent advantages. These advantages probably will be more fully realized when more experience with induction logging is obtained and when the logging techniques are developed more perfectly. Nevertheless, at the present state of development of well logging, it is not desirable to drill a strictly exploratory well with oil-base fluid as far as electric-log interpretation is concerned.

Although the potential and resistivity curves have been run simultaneously for many years, this has not generally been true of most other combination logging techniques. However, the induction-logging equipment has recently been operated simultaneously with a single-scratcher resistivity electrode. A com-

bination gamma-ray neutron equipment also is being developed.[28]

The MicroLog.—As its name implies, the MicroLog[32] reveals the minute changes in sedimentation. In contrast to conventional electric logging systems, which function best if the thickness of the sedimentary layers is greater than several feet, the MicroLog indicates the presence of sediments only a few inches in thickness. This logging method is quite conventional except for the very close spacing of the electrodes and the manner of their application in the drill hole.

The down-hole equipment consists of a rubber pad that is pressed against the wall of the hole by means of long springs attached to the mandril of the instrument. The electrodes are located on the outside surface of the rubber pad, facing the formations, but insulated by the pad from the short-circuiting action of the drilling fluid.

A standard MicroLog practice consists of recording two curves; 1-in. and 2-in., two-electrode resistivity curves. The conductive filter cake of water-base fluid present on a porous and permeable formation is detected easily since the 1-in. curve is more affected by the filter cake than the 2-in. curve. In this manner, the MicroLog detects the presence of filter cake which is indirectly equivalent to detecting the permeable interval. The MicroLog is not diagnostic of the nature of the fluid content of the formations since the technique is predominantly influenced by the filter cake and the invaded zone.

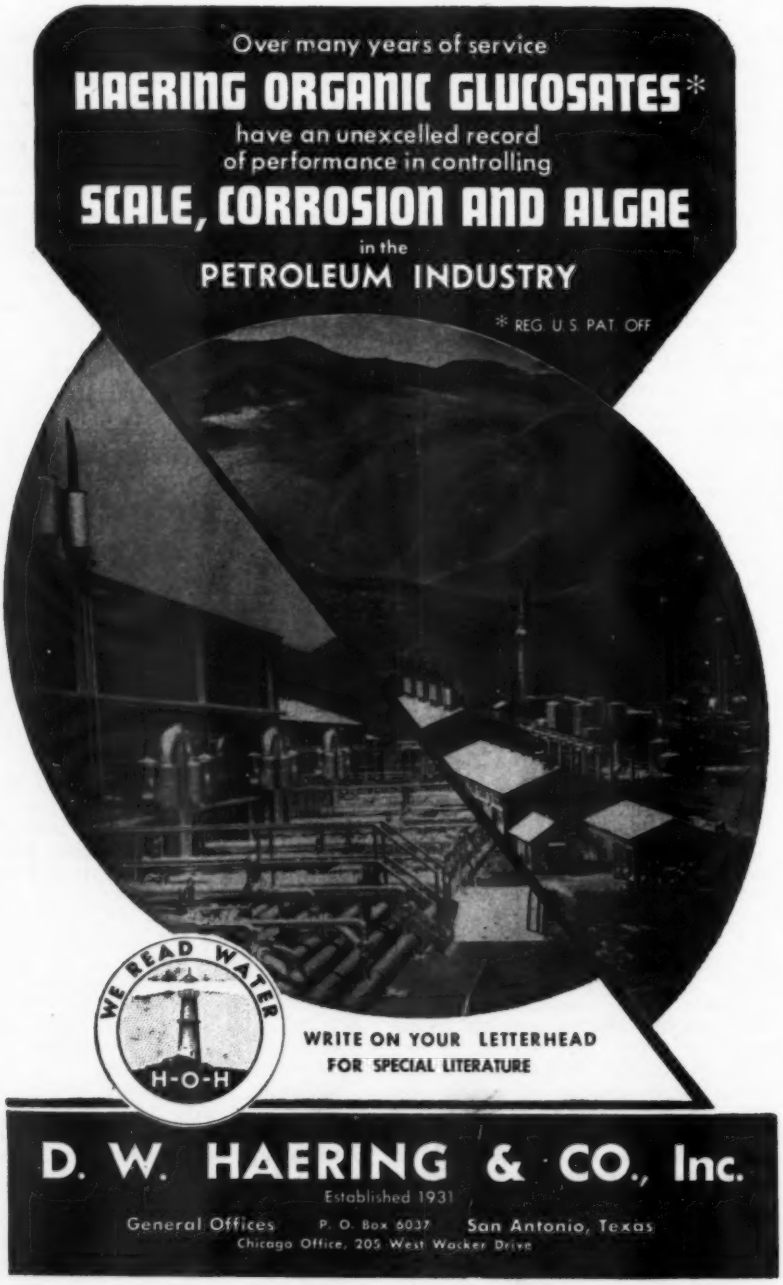
The MicroLog method of logging has been used very successfully in certain limestone-reef areas to distinguish the porous from the dense intervals. Such determinations are of great assistance in calculating reserves and for determining the continuity of the porous zones throughout the field. In an exploratory operation in formations of this sort, the MicroLog would indicate which intervals in the lime are worth of further evaluation.

Continuous electric logging at the bit.—During the period 1935 to 1941 considerable effort was expended to develop continuous electric logging at the drill bit.[33 34] The method consisted of insulating the bit from the drill pipe and providing each section of pipe with an insulated wire held within a tube brazed to the inner periphery of the drill pipe during the normalizing operation at the mill. Insulated male and female terminals at the ends of each section of pipe permitted the customary derrick-floor makeup and breakout practice. A brush box was provided between the kelly and the swivel so that connections could be made to the surface equipment housed in a portable trailer. The bit was connected to the logging cable by means of a specially insulated drill-collar and switch assembly. In this system, the bit is the electric-logging electrode. Although this method of logging obtained some success, it remained in the development stage and was never used commercially or on a wide scale.

During the last few years another company has again initiated the development of a method of continuous logging. Although the bit manifestly must still function as the logging electrode, the means of providing a connection with the surface equipment and other elements of the system are radically different from those heretofore developed.

The chief advantage of logging at the bit is the simultaneity of the drilling and logging which allows the coring and testing of an interesting horizon before deeper formations are exposed. A further consideration that will need to be evaluated by more experience is the possible advantage to be gained by logging before the invaded zone is fully established.

Although many of the characteristics of this logging method still have to be determined, it is interesting to point out one or two ways in which the method differs from the conventional electric-logging system. Since



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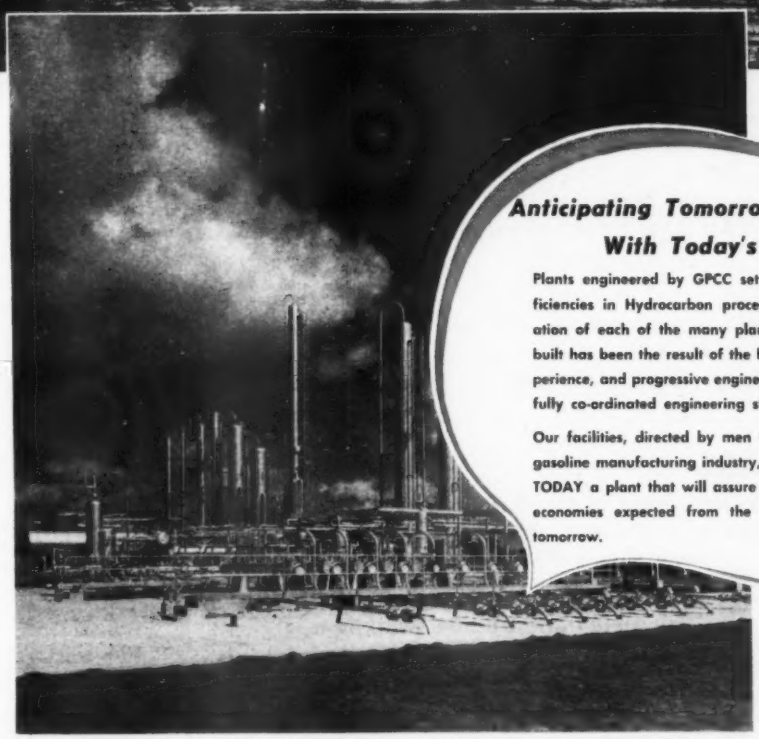

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a single electrode is utilized, bed-thickness effects should not be as disturbing as they are for the long-spacing resistivity systems commonly employed. Since the electrode is large, and since no open hole exists below the electrode while drilling, there should be less hole effect than with the conventional single-electrode system.

With this type of logging method a potential due to the contact of the steel bit with the formations will probably be an important part of the total potential measurement. It is difficult to foresee at the present time whether or not this will enhance the value of the potential curve. Furthermore, logging at the bit will make possible the recording of curves both while drilling and while pulling the pipe out of the hole. Since the filtration into the formations of drilling fluid filtrate is very likely different under the two conditions, a comparison of the two curves may possibly yield qualitative information concerning the permeability of the various strata. The above considerations outline a few of the more important ways in which logging at the drill bit differs from conventional electric logging.

Fig. 1 shows a comparison between a conventional electric log and one recorded concurrently with the progress of the drill bit. Although the Drill Logger does not strictly measure resistivity, the Drill Logger resistance curve is shown beside the electric-log resistivity curve in a somewhat displaced position for comparison purposes. An excellent resemblance between these two curves exists. The Drill Logger potential curve correlates well with the electric-log potential curve and shows considerably stronger potentials than the latter.

Drilling-fluid considerations. — The type of drilling fluid used in an exploratory operation is determined by both the drilling requirements and formation-evaluation considerations. The fluid chosen should be one that renders the various formation-evaluation methods most diagnostic and at the same time is compatible with the expected drilling conditions. While the successful drilling of a hole in the ground is not the main purpose of an exploratory well, it is most certainly a prerequisite of the operation.

The use of a drilling fluid containing oil decreases the efficiency of mud-logging methods and devaluates the significance attached to oil showings in side-wall samples. The presence of oil in the mud column will not affect adversely the conventional electric-logging technique, unless the fluid is composed largely of oil or oil base and thus electrically insulating. In this case, as previously discussed, induction logging, gamma-ray logging, or wall-scratching methods are employed. Since the data furnished by these latter methods have not yet reached the same level of usefulness as those furnished by the electric log, it is only logical to conclude that a conductive water-base fluid is ordinarily preferable for exploratory operations.

Salt water is not usually considered a good circulating fluid as far as exploratory formation evaluation is concerned, since it frequently affects in an adverse manner both the potential and resistivity curves of the electric log. The excessive invasion that may occur when using water as a circulating fluid may preclude the determination of the true resistivity of the formation and mask the results of a formation test.

Some drilling fluids have a detrimental effect on the potential curve of the electric log due to the electrochemical nature of the fluid. Such an effect has sometimes been noticed when lime-treated fluids have been employed. The effect on the potential curve is unpredictable and may possibly depend in some way on the history of the fluid treatment. In view of this effect, it is clear that the diagnostic efficiency of the electric log may be greatly reduced when such fluids are used.

Varied opinions exist concerning the characteristics that a drilling fluid should have in order to make the best possible interpretation of the

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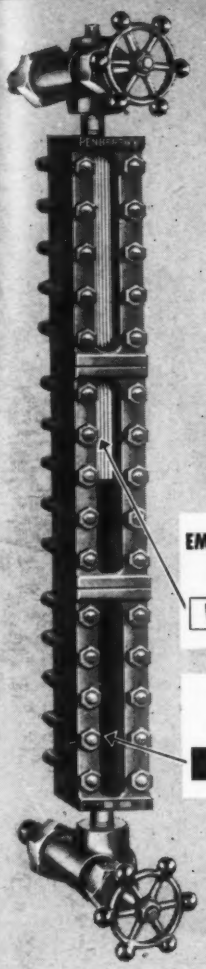

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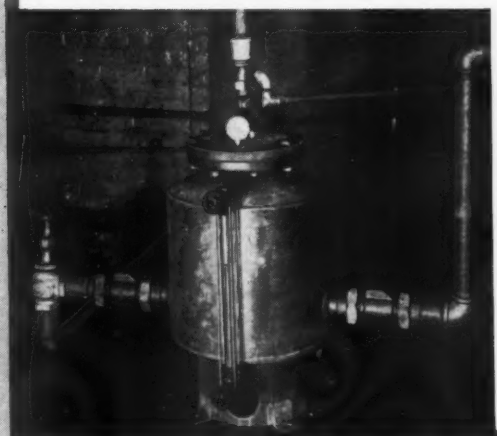

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electric log. However, taking into account as many factors as possible, it is believed that these characteristics are:

1. The fluid should be electrically conductive, and have a resistivity between 1 and 3 ohm-meters at surface temperatures.

2. Under hole conditions of temperature and pressure, the filter loss should be very small, but not zero.

3. The electrochemical nature of the fluid should be such that a normal type of potential curve is recorded.

A small but finite filter loss is desirable since the most effective interpretation of the resistivity curves is made when some invasion has taken place. Although some oil-emulsion fluids satisfy these conditions, they do not lend themselves as well to interpretation of mud-logging and coring results as a mud that does not contain oil. Thus, as far as formation evaluation in general is concerned, it is necessary to add a fourth characteristic:

4. The fluid should not contain oil.

It is realized that special methods and techniques may be developed in the future which would modify considerably the above specifications. However, these requisites are postulated on a basis of the present state of development of logging techniques and interpretive methods.

Exploratory Drilling Programs

The methods of formation evaluation that are reviewed above are the basic elements of the exploratory drilling program. In addition to a knowledge of the results obtained by the several methods of formation evaluation it is necessary to determine which methods lend themselves best to the conditions to be encountered, and the optimum combination of well-logging techniques to be employed in order economically to obtain the desired amount of information. When a complete exploratory program is formulated, many factors must be taken into consideration such as the type of drilling fluid to be employed, the nature of the formations to be encountered, probable total depth, and expected hole conditions.

Although much of the logic contained in this analysis of exploratory drilling programs is used intuitively by those directly responsible for such operations, it is believed that an approach from the nonintuitive standpoint is worth while. Such a study may serve as an outline to guide management in evaluating the recommendations made by the technical staffs of the exploratory and exploitation divisions of their organization. It may also serve as a review for those who are closely connected with the problem, and who realize that the programs adopted are sometimes apt to become too rigidly standardized due to routine usage.

It should not be construed that every individual exploratory drilling program will, as a result of the classification presented here, be immediately and readily cataloged, for instance, as Type 2-B. A program decided upon at the outset may of necessity be changed during the course of drilling due to factors that were not initially anticipated. The charts are better described as a classification of the principles used in designing programs, rather than as a classification of individual programs. Furthermore, the logging and testing methods used often deviate from a more or less accepted practice due to a particular or local condition. For instance, in a certain area the presence of a geologic formation known to cause extremely bad hole conditions might necessitate the use of a drilling fluid that is not compatible with a good interpretation of mud logging or side-wall-sampling data.

The present study has avoided the inclusion of specific data concerning the limits within which a practical and economical functioning of the various coring, testing, logging, and cementing techniques is obtained. Examples of such limits are: (1) the maximum safe depth for oper. hole formation testing; (2) the maximum

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open-hole formation-test interval for reliable formation evaluation; (3) per cent successful water shutoff tests, as a function of depth, or the probability of getting water shutoffs as a function of the distance from the cementing point to the water-shutoff point.

The reason for omitting specific limits is that they vary considerably from one area to another and, furthermore, what one operator may consider practical and economical, another may not. For any particular area, however, a study of the available statistics concerning such limits would undoubtedly be both interesting and profitable.

Classification System

The progress of an exploratory well may be divided conveniently into the intervals of drilling between consecutive electric-log surveys. It is interesting to study the ways in which the formations lying in any one such interval may be evaluated. One very complete and thorough way is as follows: (1) A commercial mud-logging service is used. (2) Significant oil shows are cored. (2) The electric log is run. (4) Interesting horizons on the electric log not otherwise evaluated are side-wall sampled. (5) On the basis of the results of the mud log, cores, electric log, and side-wall samples, formation tests are made either on the way in, on the way out in open hole, or on the way out inside casing or stub liner.

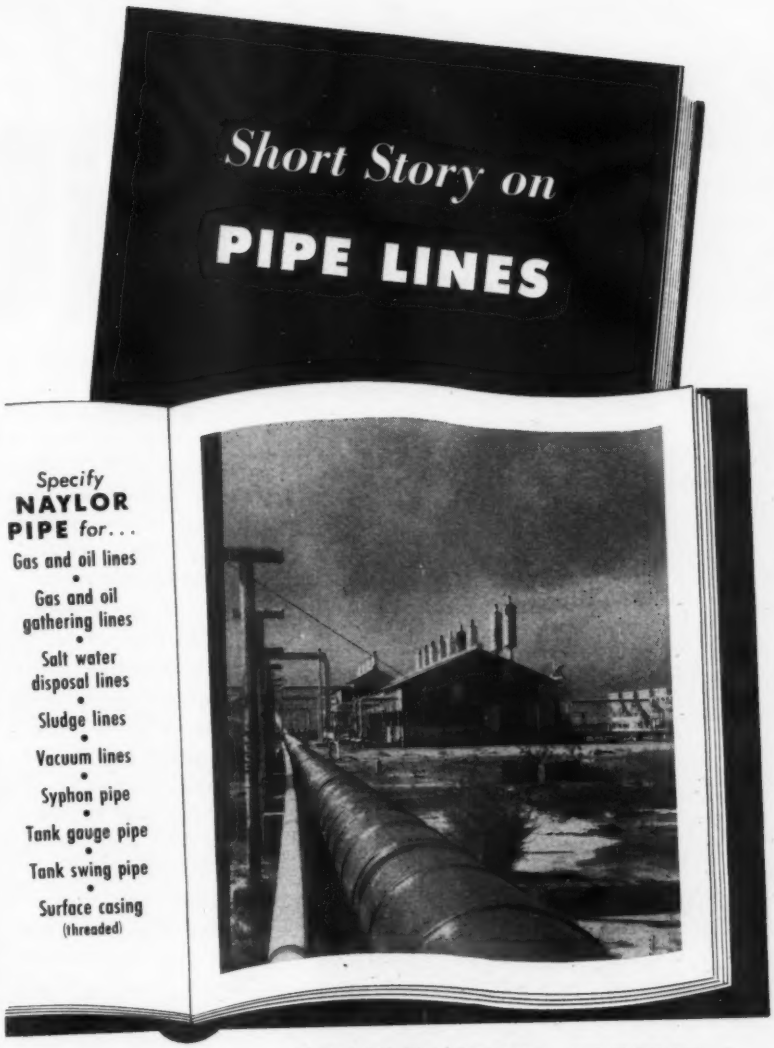
A second way of evaluating such an interval would be to proceed similarly but without mud logging, and a third way, even more abbreviated, would be to dispense also with coring and depend on the results of the electric log and side-wall cores to indicate if and where formation tests should be made or casing run.

The above discussion summarizes briefly the principles underlying the classification selected for the charts. The three charts 1, 2, and 3 are classified on the basis of when and how the formation testing is done. The three subclassifications A, B, and C represent respecively: the complete set of methods discussed above; without mud logging; and without mud logging and coring. Generally speaking, the number of techniques employed is determined by the amount of information available. Such information may consist of other electric logs in the area or known stratigraphic or structural conditions.

It should be noticed that all of the programs outlined in the three charts include as fundamental premises:

1. That the electric log is always run.
2. That interesting horizons on the electric log not evaluated by other methods are side-wall samples.
3. That an interval is formation tested if cores or logs indicate it to be possibly oil or gas productive.

In view of the stakes involved in



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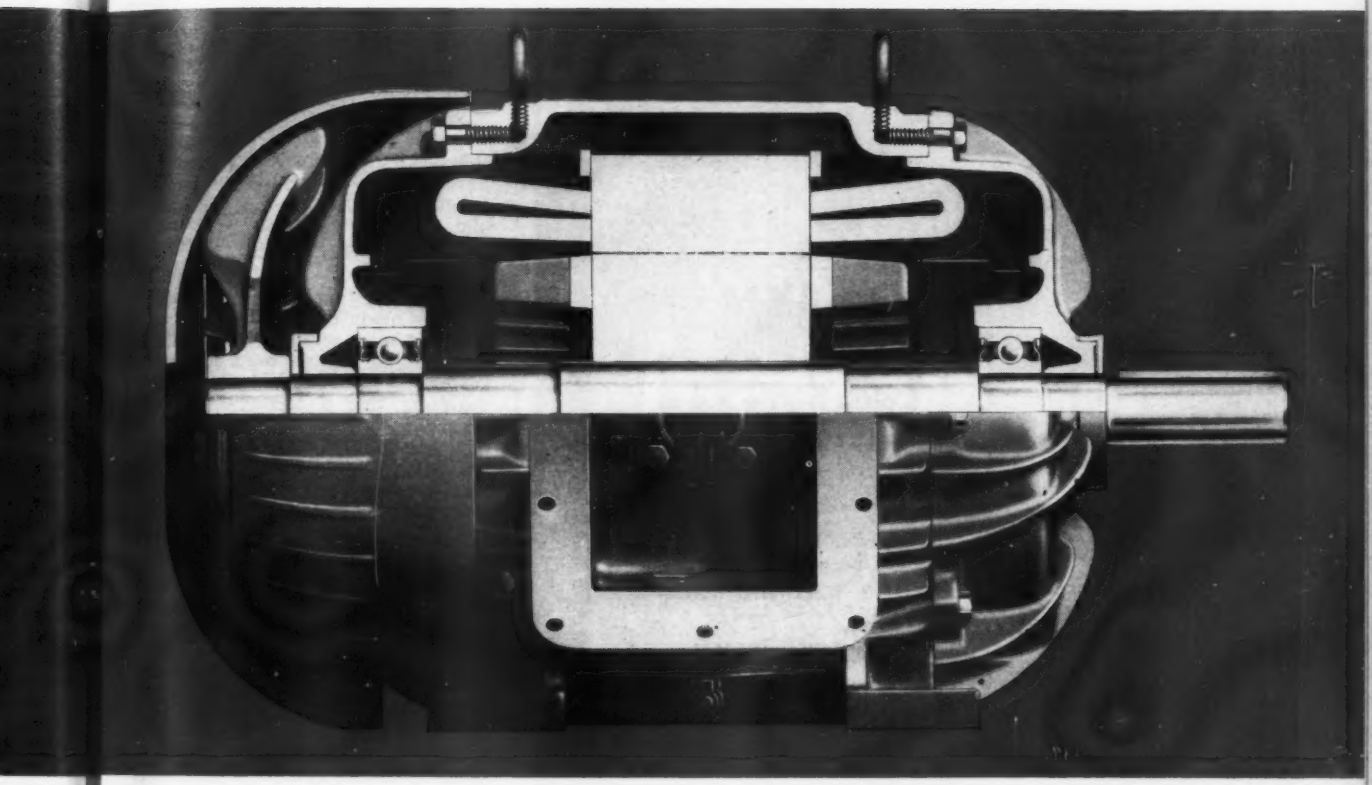

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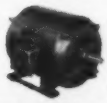

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an exploratory operation, it is believed that these premises are warranted.

The real risk taken in omitting mud logging and coring is that a commercially productive formation may not appear sufficiently interesting on the electric log to warrant further testing. This emphasizes the necessity for a competent electric-log interpretation. Certain oil-producing sands that are silty and contain salty interstitial water may look very mediocre on the electric log but still may yield commercial production. If mud logging is used and a show is obtained opposite such an interval, testing would be indicated and the interval more adequately evaluated.

If any uncertainty as to formation fluid content still remains after the logging and coring data have all been obtained, it is ordinarily judicious to make a formation test. Even then, needless to say, some holes have been abandoned with some remaining questions still unanswered. The ultimate goal in the development of formation evaluation techniques should be to increase the efficiency of these tools until the probability of missing a commercially productive horizon has been reduced as much as practicable.

The number of testing and logging methods that are actually used at one time or another while evaluating the formations penetrated by an exploratory well bore, depends on: (1) Whether method A, B, or C is chosen, and (2) on the number of oil or gas shows obtained requiring further investigation.

	A Full set of methods employed	B No mud logging	C No mud logging or coring
1.	MCLST	CLST	LST
2.	MLST	LST	LT
3.	MCLT	CLT	LS
4.	MCLS	CLS	L
5.	MLT	LT	
6.	MLS	LS	
7.	MCL	CL	
8.	ML	L	

It is interesting to express analytically the many combinations of methods that may actually arise in practice. Let M denote mud logging, C coring, L electric logging, S side-wall sampling, and T testing. Then, disregarding for the moment the order of application of the methods, or the possible use of a method more than once in any interval, the number of used are shown in the above table.

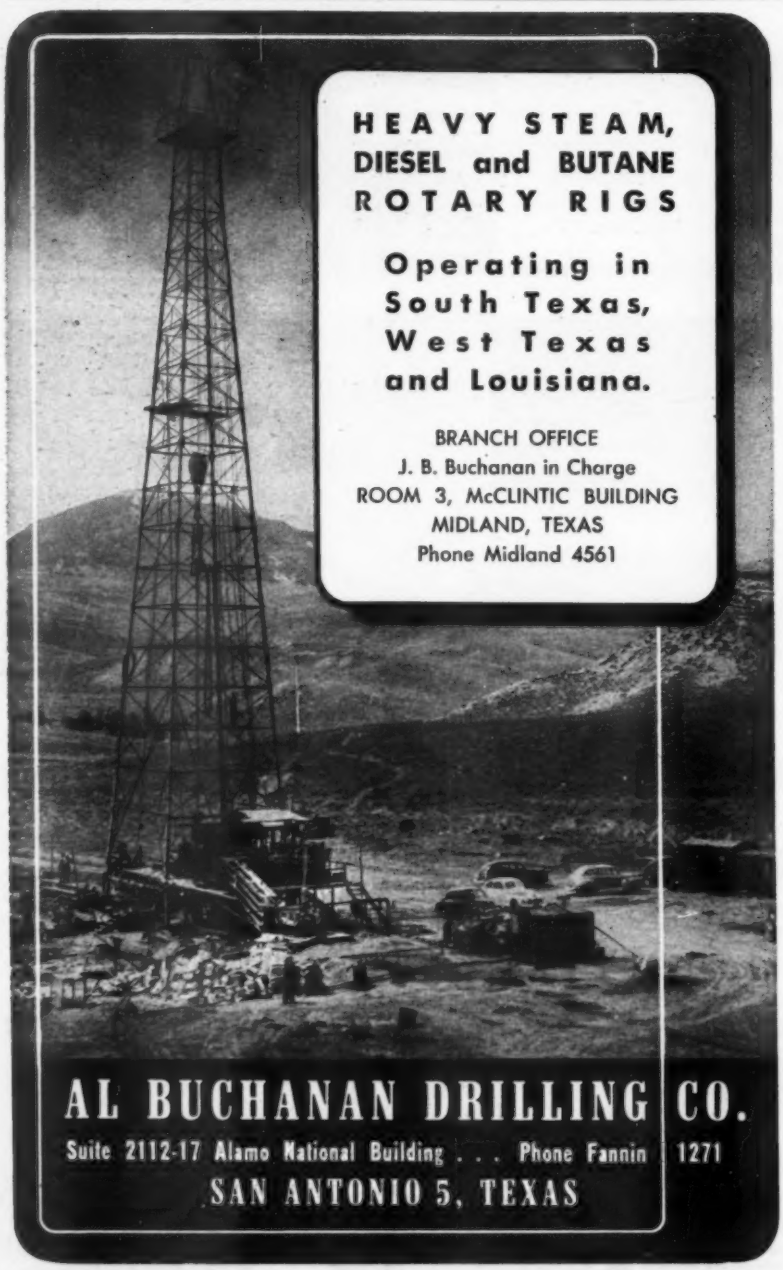
Furthermore, each of the above combinations of methods can be classified further according to the order of application. For instance, the combination MCLST may also be practically used in the orders MCTLS and MTCLS. It also frequently happens that one method may be applied more than once in any particular interval of hole. This is illustrated by MCTLST and MCTCLST. These variations are all included in the single combination 1A above.

Although the consideration of the above paragraph may appear somewhat redundant, they are included in order to emphasize the great diversity of operational procedures that may arise in practice even after a general exploratory program has been decided upon.

Exploratory-Drilling-Program Charts

The three general types of exploratory testing programs are shown in Charts 1, 2, and 3. The subject matter of the charts is self-explanatory and includes an enumeration of the advantages, disadvantages, and applications of the three general methods of testing. Although testing on the way in is in many instances desirable, there are areas in which it may not be the best way to proceed.

Before selecting a particular program, there are several very important factors which should be taken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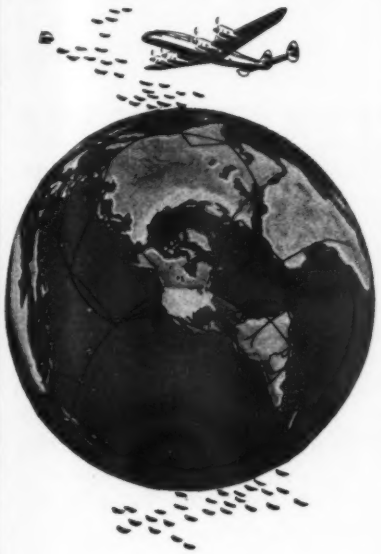

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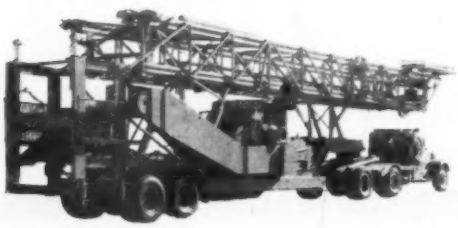

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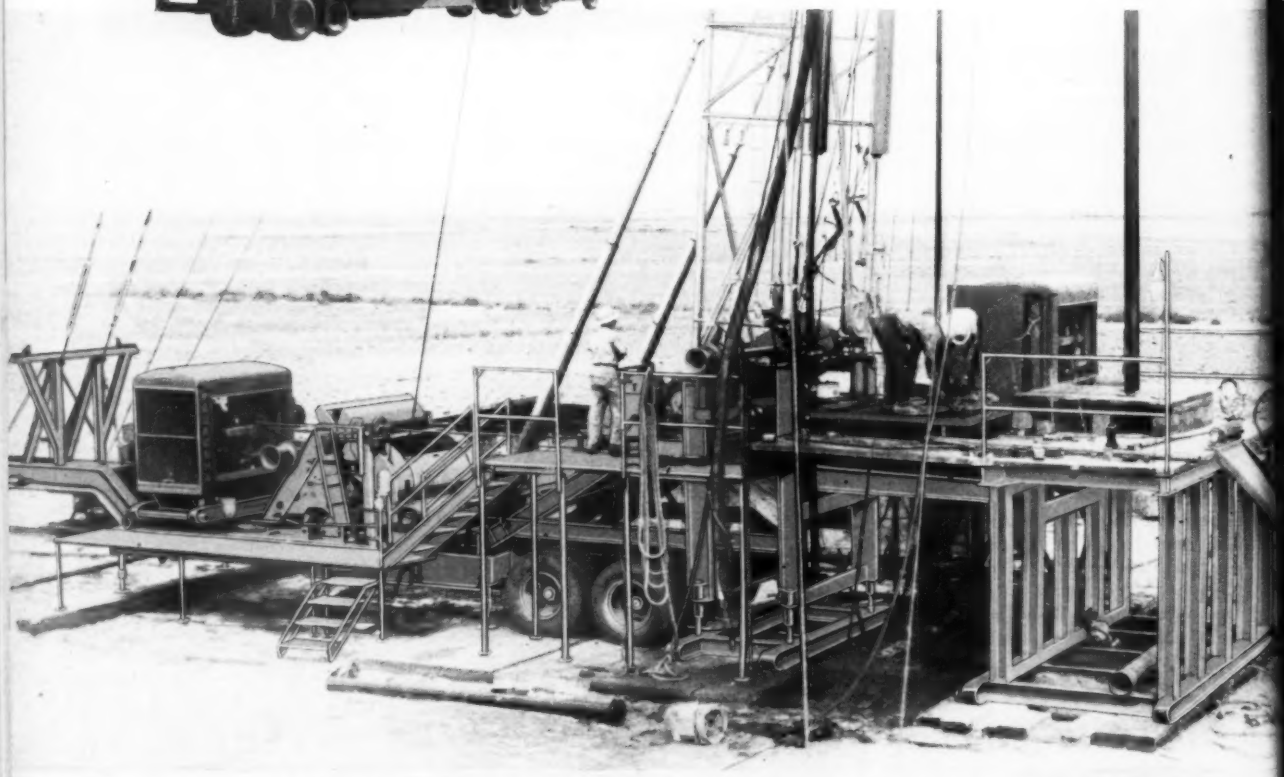

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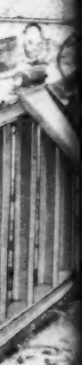

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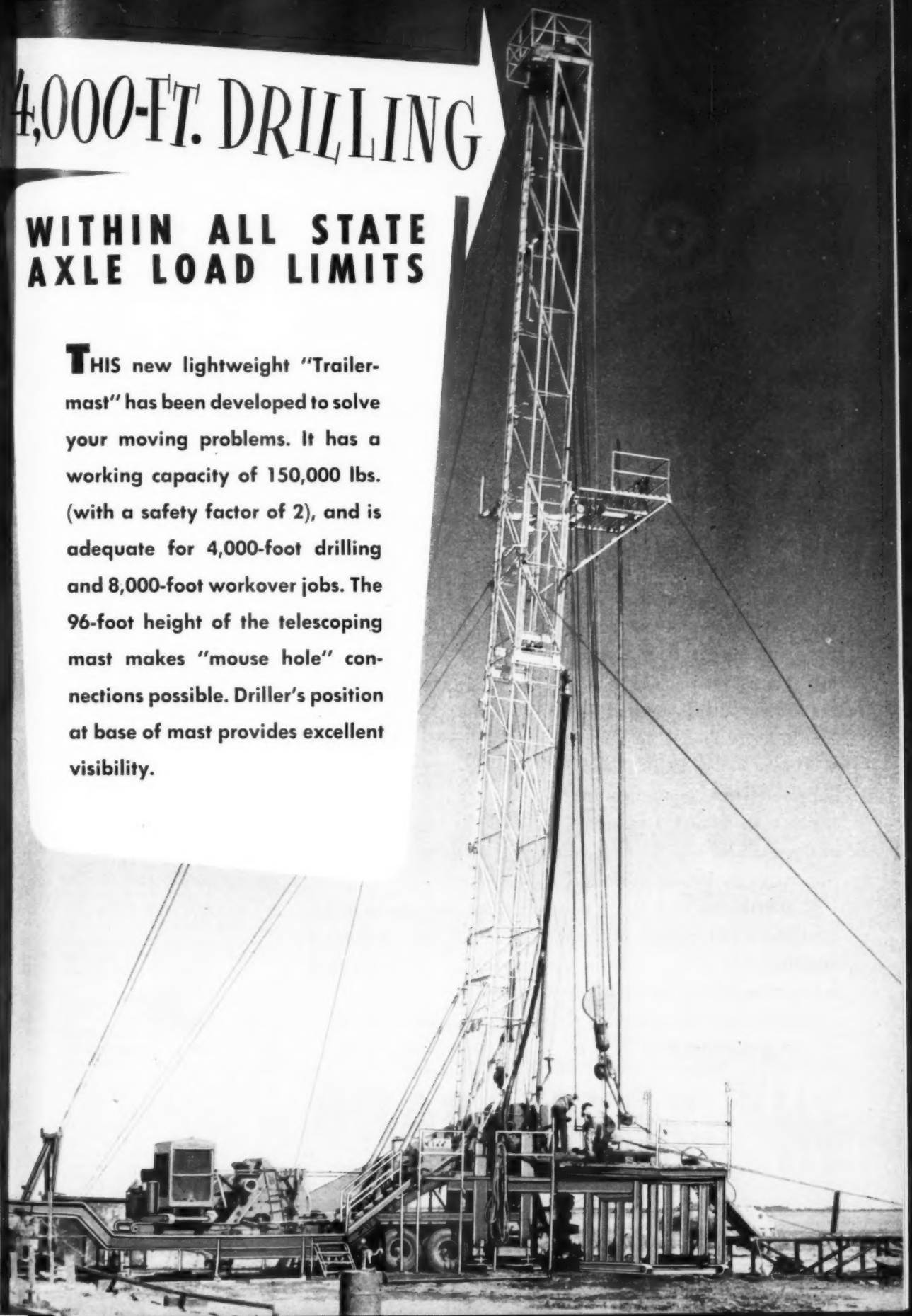

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into consideration. These may be outlined as follows:

1. Characteristics of the objective zone.

A. Type of geologic play: Stratigraphic trap, fault accumulation or anticlinal structure.

B. The number, estimated depth, thickness, and distribution of the possibly productive intervals that may be penetrated.

C. The physical nature of the objective zones: unconsolidated sand, hard sandstone, fractured chert or shale, porous limestone, or fractured limestone. Heavy oil, light oil, or gas. High-pressure zones or low-pressure zones.

D. The chemical nature of the formations: Salt, anhydrite or sulfur.

2. General subsurface considerations.

A. Number of available well logs and histories in the area:

B. Probable accuracy of electric-log correlations.

C. Degree of known faulting.

D. Accuracy of available seismic data.

3. Drilling technique.

A. Presence of high head waters.

B. Possibility of encountering zones of lost circulation.

C. Possibility of encountering zones of caving shale.

D. Presence of known gas zones overlying objectives.

E. Presence of known productive oil zones overlying objectives.

4. The effect of the type of drilling fluid used on the formation evaluation methods.

In order to illustrate the manner in which the characteristics of the formations influence the choice of exploratory drilling program, two programs used by a particular operator will be examined.

Exploration Program Used in Gulf Coast Miocene Operations:

1. Mud logging usually is employed from some selected depth between 2,000 and 5,000 ft. to total depth.

2. The hole is drilled to approximately 9,000 ft. with no coring or testing.

3. The electric log is run at this depth, and approximately every 1,000 ft. thereafter.

4. If good mud-logging shows have been obtained, or if good electric-log shows are indicated, the percussion-type side-wall-sampling tool is used to obtain samples in all of the interesting horizons. This procedure is repeated after each electric-log survey.

5. After reaching total depth, which is generally of the order of 10,000 ft. to 13,000 ft., a decision is made whether or not to set casing on a basis of—

(a). Mud-logging shows;
(b). Electric-log interpretation;
(c). Results of side-wall samples.

6. In this area and in these formations it is usually possible to tell whether or not a hole will make an oil well on the basis of the above three techniques. Casing is cemented at the base of the deepest possible productive sand and the best-looking horizons usually are tested first, regardless of whether they lie above or below other interesting sands. If all the interesting horizons look equally good, tests are made from the bottom up. All production is from sands.

It has been decided that the above exploratory drilling program is most economic and most diagnostic for the following reasons:

1. Any of the many thin sands in the long Miocene section may prove to be commercially productive in an exploratory well.

2. In this area it is dangerous to make a drill-stem test in open hole, because the soft unconsolidated formations tend to slough into the hole.

3. Little or no coring is done because the sands are thin and the drilling fast. This situation often results in the sand being penetrated completely before a core can be taken.

4. The electric log in the Gulf Coast Miocene formations is very diagnostic of fluid content.

5. Due to the soft formations, the percussion-type side-wall sampling device functions very satisfactorily, yielding good recovery. It is interesting to note that the side-wall sam-

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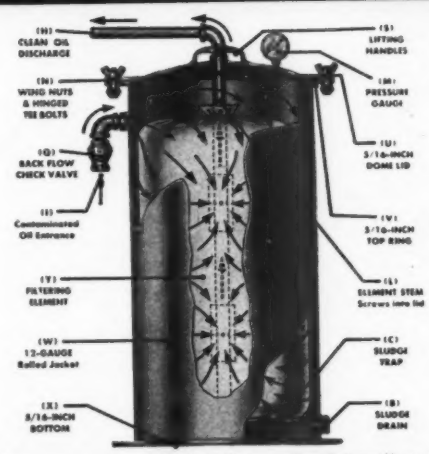
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From the above, it is clear that the thickness, distribution, number, and hardness of the expected objective sands make testing on the way out inside casing an economical and practical program. It is also important to note that the dependability of the electric-log interpretation in these formations also influences this choice.

Exploration program used in Mississippi operations. — In this area, three productive formations are present. In a typical deep Tuscaloosa well the Wilcox in the Eocene is encountered at about 4,000 ft. and the Basal Tuscaloosa in the Upper Cretaceous at approximately 10,000 to 11,000 ft. The third possibly productive horizon is the Eutaw sand, which also lies in the Upper Cretaceous and is found approximately 1,500 ft. above the Basal Tuscaloosa. Cores usually are taken in these zones, regardless of whether or not any mud logging shows are obtained.

Coring is done in reduced hole and if the cores indicate possible production, open-hole formation tests are made using a wall-type packer. The packer is set inside the reduced hole in order to obtain maximum clearance while lowering and pulling the tester. Tests are ordinarily limited to a 100 or, at the most, a 200-ft. interval.

The Eocene and Cretaceous formations are harder than the Gulf Coast Miocene formations which allows testing more safely in open hole. Percussion side-wall samples are ordinarily taken as supplementary data, particularly in the Wilcox. Although the electric log is valuable, it is not as diagnostic as in the Gulf Coast Miocene because of the extremely high salinity of the interstitial water in some of the horizons.

About three electric logs are made during the drilling of a Basal Tuscaloosa exploratory well. The first log is made after penetrating the Wilcox sand, because it is so easily invaded by drilling-fluid filtrate. Cuttings analysis is more effective in this area due to the larger cuttings that are obtained in the harder formations.

One important point emphasized by this operator is that a mud-logging show is seldom drill-stem tested without first taking a core, or at least obtaining side-wall samples in the interval. In other words, a formation test is never made on the basis of a mud-logging show alone. This procedure eliminates the testing of mud-logging shows obtained in intervals that a conventional core might show to be noncommercial.

From the above, it is clear that exploratory drilling operations in the Eocene and Upper Cretaceous in Mississippi lend themselves very well to testing on the way in. The harder formations and more definite objectives make it possible to carry out such a program economically. Furthermore, the less-diagnostic electric logs and side-wall samples lower the efficiency of a program that depends heavily on these services.

If some horizons remain unevaluated after reaching total depth, and after having diligently employed the open-hole testing methods, casing is set and drill-stem tests made in these intervals on the way out.

Exploration in limestone formations. Since exploration in limestone formations differs considerably from that in sandstone formations, it is well to include a discussion of some of the factors relating to the detection of oil in limestone exploratory wells. In a discussion with a representative of an operator who has had considerable experience with limestone operations, the following criteria for formation evaluation were advanced as being reasonably correct:

A. Limestone wells in which circulation is not lost:

1. A commercial mud-logging service should be employed on all limestone exploratory wells since almost invariably the drill cuttings returned from an oil zone show fluorescence.

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Such fluorescence is considered to be a more reliable indication of oil than that obtained by any of the other testing methods, with the exception of drill-stem testing.

2. When an oil zone is penetrated there also is often a show of gas in the drilling fluid which can be detected readily by a mud logging technique. However, the lack of gas show does not condemn a zone since oil zones have been penetrated with no resulting gas show in the drilling fluid.

3. From a standpoint of distinguishing between oil and water bearing intervals, the conventional electric log is almost useless in limestone exploratory wells, but may be used to some extent in a quantitative manner after a field has been discovered and experience with the electric logs obtained. MicroLogs assist in determining what intervals of the limestone section are porous.

4. In case there is doubt as to the fluorescence of drilling cuttings, side-wall samples are obtained.

5. When drill-stem testing limestone formations in which circulation has not been lost and there have been some indications of oil, side-wall packers are set and swabbing is continued for as many hours as necessary.

B. Limestone wells in which circulation is lost:

1. Although a commercial mud-logging service is employed, cuttings are not normally available due to lost circulation.

2. The regular procedure in case of lost circulation is to side-wall sample to determine if there is any fluorescence.

3. If some fluorescence is indicated, side-wall packer tests are made, but usually of moderate duration. The shorter testing time is used due to the danger of sticking the packer on account of the lost circulation condition.

4. If the side-wall samples are fluorescent but circulation loss has been so great that diagnostic drill-stem-test results are not obtained, it is then necessary to decide whether or not to set casing and make a longer test. This important decision is made by taking into consideration all the factors which bear on the possibility of finding oil in the zone.

A California exploration program.—As in other parts of the country, various types of exploratory drilling programs are used in California, depending on the area and the preference of the operator. In order to be complete, it is desirable to include a specific example of one California exploratory drilling program that has proved to be economical and efficient.

The particular drilling program chosen as an example is essentially the 1A type (testing on the way in). It was employed in the drilling of a

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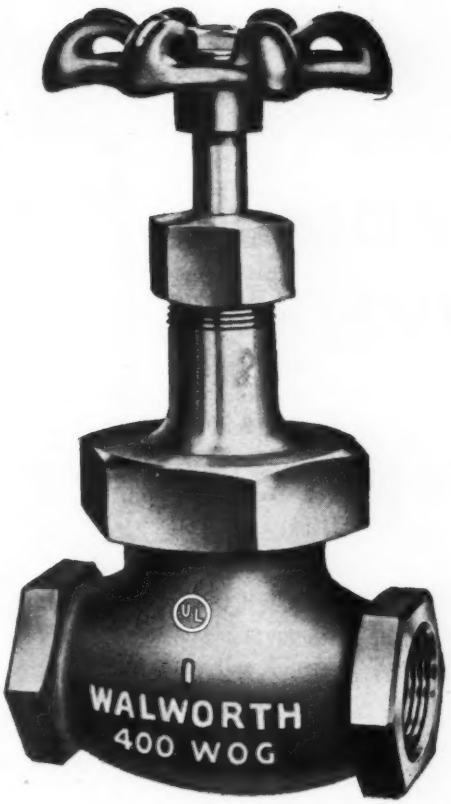

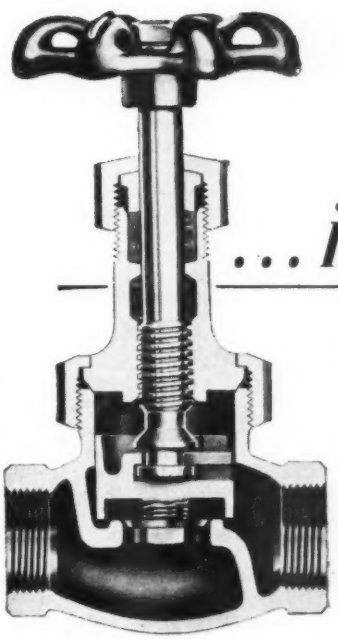

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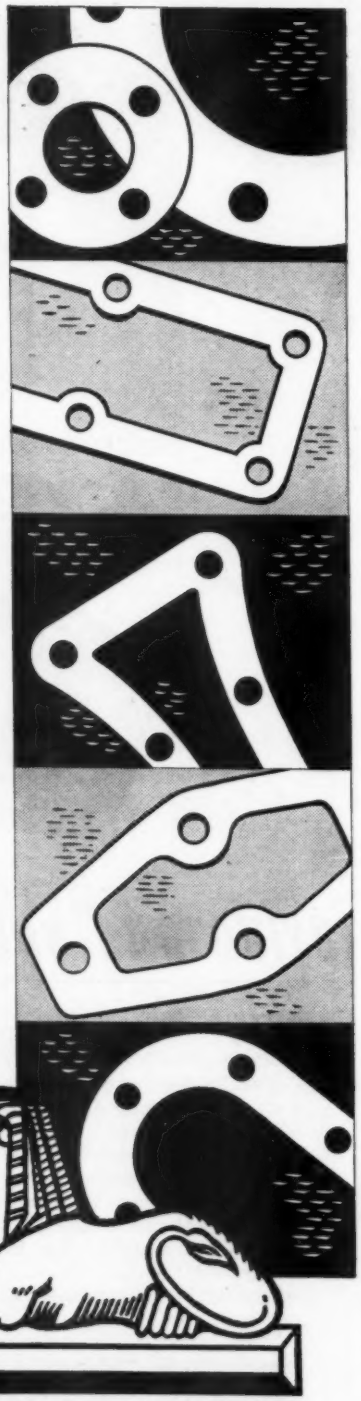

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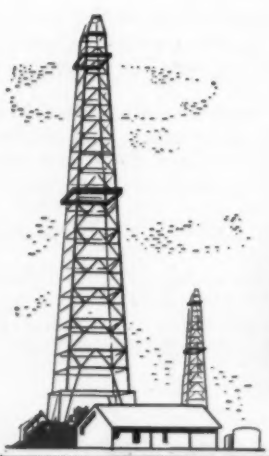

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well to primary objective sands in the Upper Miocene. Due to the known geological conditions above 7,000 ft., an abbreviated program was employed to this depth. The main features of this program are as follows:

1. After cementing casing below fresh-water surface gravels at about 1,000 ft., an 11-in. hole is drilled to 7,000 ft. taking ditch samples and spot cores below 3,500 ft. for paleontological and geological information. All promising sands indicated by the electric log are side-wall sampled.

2. A mud-logging service is installed at 7,000 ft., and all subsequent hole is logged for oil and gas shows. Whenever a significant oil show is encountered, a core is taken in reduced hole and coring is continued as long as oil sand is recovered. All cores are analyzed for porosity, permeability, formation factor, and fluid content.

3. If it is not possible to determine the potentialities of the sand from these data, formation tests are made if hole conditions permit.

4. If the primary objective sand is cored and found to be oil bearing but to have a low permeability, consideration is given to cementing casing and changing to oil base drilling fluid before coring more than 30 ft. into the sand.

5. If the primary objective sand is found to be wet, and no other attractive measures have been encountered, the hole is deepened approximately 1,000 ft. below the top of primary objective sand, in order to make certain that the section contains nothing of value.

6. Prior to abandonment, all promising sands not previously cored or tested are side-wall sampled.

Cost of Formation Evaluation

Whether it is decided to test on the way in or on the way out may depend, as previously demonstrated, on the characteristics of the geologic section. It is not always possible, however, on this basis alone to discriminate between the advantages to be gained by using one or the other of these programs. The formations may lend themselves as well to testing on the way in as to testing on the way out. This situation may arise when a very promising deep primary objective is overlain by several formations, that although not nearly as promising, may require further evaluation.

In this case, should the added time and added danger of losing the hole while testing be incurred by testing on the way in before evaluating the primary objective? Should the heavy deep-hole drilling equipment be used in this somewhat uneconomical way to explore at shallow depths, or should a separate hole be considered for such exploration? On the other hand, however, more representative tests can be obtained in the shallower formations when testing on the way

in. They can often be tested at much less expense than when testing in open hole or behind casing on the way out. Many tests behind casing become very expensive due to the difficulty of obtaining water shutoffs above and below the intervals to be tested.

From the above it is clear that when the type of program selected is not established by subsurface conditions, the decision should then depend on a comparison of the cost and efficiency of the methods. The efficiency of the methods is carefully considered in the three charts under the sections entitled "Advantages" and "Disadvantages."

A significant comparison of the costs incurred using the various formation testing methods outlined in charts 1, 2, and 3 is very difficult to establish since innumerable considerations bear upon the problem. Attempts to set up a significant comparison on the basis of testing an entire geologic section have failed for this reason. Furthermore, such a comparison would only be of significance for the particular geological section chosen. It is, however, believed that a significant comparison of these costs can be made if it is limited to the testing of one interval at a particular depth.

The interval chosen for consideration is a 100-ft. interval at a depth of 8,000 ft. The interval consists of interbedded sandstones and shales. In each instance, the "A" type of program is utilized. In each instance a good mud logging show is obtained at 8,000 ft. after which 100 ft. of oil sand, and shale are cored. The costs are expressed in rig-time days and the service charges for the formation tester, core barrel, and gun perforator are omitted. The interval is tested in the following four ways:

Test on the way in. Method 1A. (Reduced-hole test):

1. Wire-line core 100 ft. of reduced hole.
2. Make shoulder formation test or side-wall test in reduced hole.
3. Ream 100 ft. of reduced hole.

Total rig time above operations—3½ days.

Test on the way in. Method 1A. (Full-hole test):

1. Conventional core 100 ft. of full hole.
2. Make side-wall packer test.

Total rig time above operations—3½ days.

Test on the way out in open hole. Method 2A:

1. Conventional core 100 ft. of full hole. (Continue operations to total depth).
2. Lay cement bridge in hole.
3. Make side-wall packer test.

Total rig time above operations—5 days.

Test on the way out inside casing. Method 3A:

1. Conventional core 100 ft. of full

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hole. (Continue operations to total depth and set casing.)

2. Squeeze and obtain water shut-off below interval.

3. Squeeze and obtain water shut-off above interval.

4. Gun perforate horizon to be tested.

5. Make formation test inside casing.

Total rig time above operations—8 days.

It is to be noted that the test made inside the casing is most expensive in spite of not attributing the cost of the casing to the operation. The latter cost is, of course, a very appreciable cost but was omitted from the cost evaluation since it is very difficult to determine for the general case what portion of this cost should be attributed to any one test.

To illustrate the indeterminateness with which the cost of the casing can be broken down consider the following. If the test is successful and commercial production results, casing will be set in any case and the cost of the casing would be involved in all four instances. The over-all economics would then not differ appreciably for the four methods. However, if all tests evidence noncommercial production, then most certainly the cost of the casing should be included in the cost of testing.

Known production overlying the interval of exploration would also modify the proportion of the cost of the casing that should be charged to the testing cost. Statistics indicate, however, that in an exploratory operation, the chances are far more of not finding oil than finding it. Thus, the cost of running pipe in the hole in order to test on the way out must certainly be chargeable to a great extent to the cost of testing. When deciding to run casing for the purpose of testing on the way out, not only should the probability of finding oil be considered, but also the probability of missing an oil field. In fact, this should be considered before it is decided to employ a program involving testing on the way out.

To summarize, the type of testing program adopted depends on the answers to the following questions:

1. How do the subsurface conditions lend themselves to the various methods of testing?

2. What is the relative efficiency of the various methods? What are their advantages and disadvantages?

3. How does the relative cost of testing by the various methods enter into the economics of the entire exploratory operation?

The cost of the individual formation-evaluation services and the rig time they utilize is fairly well known and need not be discussed in detail. Ordinarily the total cost of electric logs, dip-meter surveys, side-wall samples, and core analysis including any rig time they involve, is only 2 to 5 per cent of the total cost of an exploratory operation. The greater part of formation evaluation cost is included in coring, formation testing, and mud logging.

In view of what might be considered a relatively low cost for electric logging, dip meter, side-wall samples, and core analysis; and, furthermore, in view of the importance of the decisions that are often made on the basis of these results, it would appear that a sufficiency of these less-expensive methods should be employed. Consequently, it is desirable to core analyze rather completely any sand cores obtained from a formation that might represent a commercial reservoir in the well under consideration or at some other location. This is particularly true in view of the cost of coring. It would also appear economical to run the electric log at frequent intervals when nearing the objective horizons in a deep exploratory well. Lastly, despite the rather qualitative information obtained from side-wall samples, it is desirable to sample thoroughly any questionable horizons not well evaluated by the other techniques employed.

Acknowledgment

The conception of the need for a comprehensive review and analysis of exploratory drilling procedures is directly credited to J. E. Toussaint,

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Much of the information constituting the nucleus of this analysis has been generously furnished by the exploration and the development personnel of Standard Oil Co. of California and other oil producing companies. To these persons, the author expresses his sincere appreciation and indebtedness.

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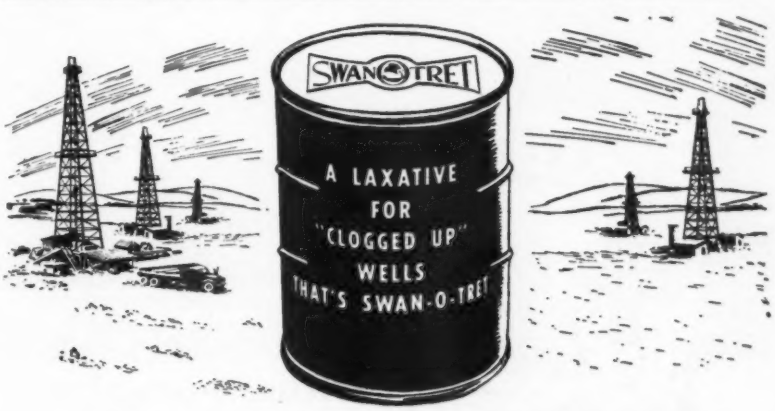

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Large-Diameter River Crossings

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by F. Hill Sanders, Jr.

ABSTRACT

The technical aspects of this paper are confined to a description and comparison of the materials, designs, and methods of installation employed by engineers and constructors in laying large-diameter pipe lines under major rivers.

The chemical and physical properties of steel used in making pipe are listed, and an attempt is made to indicate certain preferences and results obtained by the use of steel varying in chemical composition. The materials used for protection from corrosion are discussed, and conclusions based on opinions from different users are drawn.

Considerable space is devoted to the controversial question of design. Although no definite conclusions can be reached regarding design, it has been shown that, given certain conditions, engineers and builders are likely to follow a general pattern in selecting a type of crossing. Because of improvement in materials, and equipment available today to the pipe-line industry, construction methods vary considerably; but again it is shown that, conditions being alike, methods of installation are generally similar—differing only with the individual opinions of men who make up the oil and gas industry.

WHEN it is necessary to cross a major river with a large-diameter pipe, the problems which are to be studied might be enumerated as follows: selection of the site for the crossing, selection of the pipe to be installed, design of the crossing, selection of coating and weighting materials, installation methods, and inspection and test to insure good workmanship.

Selection of the Crossing Site

Usually the general area in which a river crossing can be made is determined by the proposed route of the line and, often, existing facilities and the necessity of including certain points along the line dictate the positive location. However, when an area of choice does exist, the factors entering into the selection of the best place should be considered, and the line so routed should take advantage of the most desirable site within such area of choice.

To begin with, all available information with respect to the river must be at hand. High and low-water stages, maximum width and depths to be expected, current velocity, angle of slope of banks, accessibility—and last, but by no means least—bottom stability. The U. S. Army Engineers have been studying river characteristics for many years, and their advice and information are invaluable.

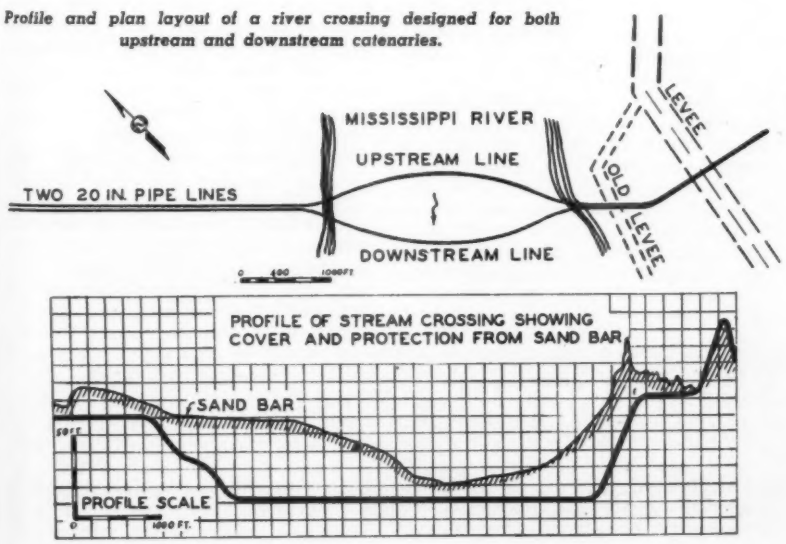
The pipe liner must usually settle for a site with certain vital features, and hope for the best in the rest. For example, it is a "must" that the banks and bottom be stable enough to withstand the effects of scouring* and erosion which might uncover and leave suspended any part of the line after installation.

If dredging operations are to be attempted, the depth of the water at all stages during the anticipated construction time must be considered, because dredges are limited to the depth in which they can perform. A selection of the construction period when the river is at its extreme low-water level is very important because high-water stages, in addition to causing greater depth, could widen the river to a great extent and increase the current velocity.

It is important that the crossing be made at a straight section of the river rather than in a curve, because the water action on the banks causes changes. A uniform bottom is desirable because the presence of any degree of variation would necessitate a deeper trench—with a resulting increase in the volume of the earth to be moved.

*Washout of the stream bed.

Profile and plan layout of a river crossing designed for both upstream and downstream catenaries.



To fail in trenching to the deepest point would be to invite disaster from a suspended section of pipe. Sand bars are to be avoided, if feasible, because of their tendency to shift; and, if they must be crossed, the line should be placed to a depth which will afford stability. All of this adds up to construction problems and cost.

From an observation of the crossing sites selected by various companies, as well as the working period, it is apparent that final security for the line and favorable water stages were the overriding factors in location, even though installation costs were in some cases considerably higher than would have obtained at a less desirable site.

Selection of the Pipe

Selection of pipe for a river crossing requires much more thought than that for land lines, as it is a relatively simple matter to repair overland lines; whereas in the vast majority of

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Paper presented at pipe-line symposium, thirtieth annual A.P.I. meeting, Los Angeles, November 14.

cases a river line cannot be repaired, but must be replaced.

We have observed that some companies have saved substantial amounts of money on land lines by using a pipe made from steel with a higher carbon content than is considered ideal for construction and welding purposes. In such cases, the harder steel allows for thinner wall thicknesses without decrease in the tensile strength.

With the 1,000-mile lines of today, it is easy to see that a very slight reduction in wall thickness can represent a tremendous dollar saving in steel and shipping costs. On the other hand, high carbon steel contributes to welding difficulties and has a greater tendency, especially at low temperatures, to snap. There is calculated risk in this, of course, with initial savings balanced against possible excessive "breakage."

Most river crossings are relatively short, and any saving in weight per foot from this practice would be negligible as compared to risk from breaks—and the consensus on selection of river pipe is that brittleness is to be avoided at all cost. In river lines we only take those risks—calculated or not—which are forced upon us.

Generally speaking, most large-diameter crude-oil lines on land have walls varying between ¼ and ⅜ in., with carbon and manganese in the 0.28 to 1.00 per cent range, respectively—with some slightly higher. Studies of various river crossings indicate that seamless pipe with a wall thickness from ½ to 1 in., with a tensile yield test of 50,000 psi. and with a lower carbon content—usually in the 0.20 to 0.30 per cent range, with an 0.30 per cent maximum—is favored. The variation in wall thickness from ½ to 1 in. results from the difference of opinion on how best to add weight for negative buoyancy; it has nothing to do with operating pressures.

TABLE 1
Summary of Chemical and Physical Properties of Steel Used by Various Companies for Land Pipe

Size (in.)	Wall thickness (in.)	Carbon (%)	Manganese (%)	Tensile yield test (psi.)
24	0.300	0.22 to 0.30	0.55 to 0.90	52,000
26	0.250	0.20 to 0.30	0.90 to 1.25	52,000
26	0.281	0.20 to 0.30	0.90 to 1.25	52,000
26	0.312	0.30 average	1.00 average	52,000
26	0.312	0.32 to 0.38	1.20 average	52,000
14	0.250	0.30 average	1.25 average	45,000
26	0.303	0.30 to 0.38	1.20 to 1.40	52,000
22	0.281	0.22 to 0.32	1.00 to 1.10	50,000
20	0.250	0.33 average	1.28 average	42,000

TABLE 2
Summary of Chemical and Physical Properties of Steel Used by Various Companies for River Pipe

Size (in.)	Wall thickness (in.)	Carbon (%)	Manganese (%)	Tensile yield test (psi.)
20	0.500	0.20 to 0.30*	0.55 to 0.90	50,000
26	1⅛	0.21 to 0.29*	0.65 to 1.00	52,000
20	0.500	0.20 to 0.30*	0.60 to 1.00	45,000

*Maximum.

Design of the Crossing

Next comes the design of the stream installation which will govern construction methods. It must be decided whether a single or dual crossing will be made. Will the line or lines be put in straight across the stream; will they bow upstream, downstream, or both? Often the decision as to single or dual lines is determined by operating necessities, construction costs, and the considered value of an "insurance" line.

As previously pointed out, the continuous operation of the line is all important. If a stream or body of water has a stable bottom, and if it is static or almost so, a straight crossing, because of obvious savings in pipe and construction, is most generally used.

In rivers such as the Mississippi, Missouri, and others with a flowing current of from 4 to 10 m.p.h. there is considerable difference of opinion as to direction and value of camber in relation to the current. These questions arise: Which is best—an upstream catenary or a downstream catenary; and what is the ideal curvature in such lines? These questions of design are considered only when the river bed is earth or silt. If it is solid rock, there is no question that a line straight across should be used.

Proponents of the upstream bow say in its favor that pipe in compression is less subject to outside force and will not exert any "pull" on the land lines. Rather, they contend that any action against the pipe will merely communicate itself to the land line, which should be adequately covered and anchored by the trench and backfill—thus minimizing the possibility of a break under water. Engineers also believe that, if the current ever does scour beneath the pipe and cause it to "swing," the weight of the line and the slack from its upstream curve will force it to follow the bottom down.

Engineers who favor the downstream catenary do so on the theory that pipe in tension, if it ever is suspended in the stream bed, will better resist "rippling" action by the river current than pipe in compression. Furthermore, they point out that the pipe is already in more tension than most currents would develop, and that the water would push down rather than up—thus helping to "reseat" the line. It is true that a short section of an upstream bow, caused by concentrated action, could go into tension, thus forming an undesirable S-curve.

Certainly there is something in favor of each design, and in one recent major crossing of the Mississippi dual 20-in. lines were installed, with one bowing each way. The degree of curvature for either type of bend seems to be determined by the amount of natural "sag" the pipe will develop without mechanical bending, and by the distance desired between lines.

The distance which separates the line should be sufficient to prevent the same scouring action which affects both lines. It should be pointed out here that lines which have been constructed with the use of each discussed design have been lost to the river; also each type has been successfully installed and maintained. To indicate the line of thought on design: Six crossings of major rivers were studied; two bowed upstream, two downstream, one both ways, and the other was straight across.

Pipe Coating and Weighting

Coating.—Although practically all companies are agreed that coating for corrosive protection is necessary, they differ somewhat on the type of covering and its thickness. For river lines, it appears that many companies favor a somastic-type coating from ¼ to ⅝ in. thick. Others use a coal-tar enamel applied in varying thicknesses, and still others prefer a glass-fiber and asphalt coating.

In practically every case, the river lines are isolated from the cathodically protected land lines by insulating flanges. In many cases no cathodic protection is provided for river lines, as their comparatively short span does not allow appreciable current "buildup," thereby justifying the installation of cathodic units. Conclusive results in this rapidly changing field are necessarily limited.

There is no doubt that coating practices have improved during the past few years, but sufficient time has not yet passed to allow tests extensive enough to establish definitely any over-all "best" method of pipe coating. In addition, the cost of dif-

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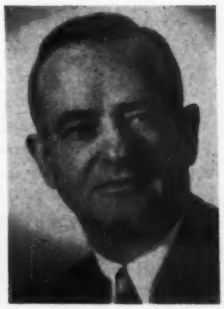
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SINCE ITS ENTRY into the oil business in 1920, Sunray, which symbolically has the words *"Natural Power"* in its products trade mark, has become one of the largest independents in the producing and refining divisions of the oil industry.

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During the period from 1921 to 1946, Sunray absorbed the Sunray-Ash-Muse Drilling Co., the Crude Oil Development Co., the Vee Oil Co., the Sun Royalty Co., the Operators Oil Co., the Homaokla Oil Company, the Superior Oil Corporation, the Darby Petroleum Corporation, the Bel-Air Oil Co., the Bell Oil & Refining Co., and the Transwestern Oil Company. In addition to greatly accelerating the normal, steady increase in producing properties and reserves achieved as a result of Sunray's own exploratory and development efforts over the years, this series of acquisitions and mergers also provided the Company with refineries at Allen, Oklahoma, and Santa Maria, California.

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In June of this year—which marked Sunray's 30th anniversary—Barnsdall Oil Company was merged into the Sunray organization. As a result of this merger, Sunray's oil and gas reserves were approximately doubled and its current production was increased to a figure of approximately 75,000 barrels per day net. Refining capacity is 45,000 barrels daily.

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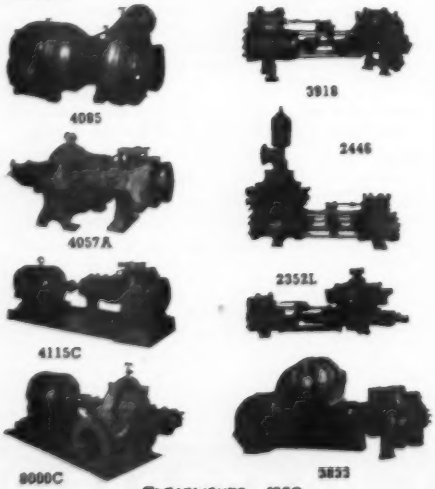

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ferent protective measures is always a factor.

Although there will certainly be dissenters to any one recommended practice, the consensus in the corrosion field is that a somastic-type coat is the most favorable means available today to the pipe-line industry; but some feel that its cost is prohibitive except in special cases, as in major river crossings. Even so, it must be decided whether the importance of the crossing and the possible expense of replacement because of corrosive elements justify the cost of somastic.

Many prominent engineers feel that crossings of such rivers as the Mississippi, because of the tremendous construction expense, call for the use of the absolute best in material which makes up the line, without consideration of cost. With the current interest and research in corrosion protection, the next few years should provide some highly interesting results to the industry.

In conjunction with protective covering, it is of interest to observe the methods employed by owners and builders for adding weight to underwater lines for construction purposes so as to increase stability and, in certain instances, to increase protection against corrosion. In certain salt-water areas marine "borers" are so destructive to the steel that a concrete overcoat up to 2 in. thick has been used to prevent their contact with the pipe.

Weighting. — Possibly the oldest means of weighting pipe is the addition of cast-iron or concrete clamps, attached at intervals, to provide a negative buoyancy. This method is effective for its primary purpose, viz., that of sinking the line; and it enjoys considerable use among builders of large-diameter lines. Although popular with some, others point out that a clamp, because of its concentrated weight on a very short section of the line, will promote fatigue, and will eventually develop a weak spot at or adjacent to the clamp.

Construction men have objected to the use of clamps because they make the pipe more difficult to install, particularly where long sections have to be pulled or pushed in place; and corrosion engineers state that any addition to the outside of the pipe which has edges, however, rounded, will promote corrosion by its eventual contact with the bare pipe. To overcome these bad points, efforts have recently been made to develop a system of continuous coating of heavy material applied on top of the corrosion protection which would evenly distribute the extra weight and facilitate handling.

One company pioneered in this field during 1949 by developing and using a 2-in. overcoat of extruded concrete applied continuously, except at joints which were left bare for welding and which were somastic coated after the weld had been made. This method proved very successful, and since then it has been used in other crossings. No doubt there is room for improvement; and already another mix, which contains heavier ingredients than concrete, has been developed; this allows for a thinner coat, and still provides the 15 to 25 per cent negative buoyancy desired by many in installing river pipe.

One company recently selected 26-in. by 1⅛-in. wall pipe for a mile-long crossing of the Hudson River. The negative buoyancy of this was 27 per cent, and no additional weight was required for sinking. It was felt that the added cost of steel was compensated for by the safety gained, by the savings accomplished by eliminating outside weight, and by the ease of installation.

In many cases builders have submerged pipe by filling with water and displacing with oil; they have depended upon this additional weight to sink the pipe and hold it in place. This, of course, is less expensive in materials and construction; and, when the line is adequately covered under the stream, it is safe enough. However, in pipe larger than 10-in., any emptying of the line, or uncovering of backfill, can result in loss of the crossing.

Methods of Installation

Construction methods for underwater crossings vary according to the characteristics of the stream, the design of the line, bottom conditions, and the amount of trench required. For deep rivers with mud or silt bottoms, dredging is generally used to provide the trench; but as previously pointed out, there is a limit to the depth which can be dredged.

Recently the longest suction-type dredge in the world was used to excavate the under-water trench for a crossing of the Mississippi River. This was a dual installation, with one line bowed upstream and the other downstream. The lines were about 800 ft. apart at the center; and two trenches, each about 150 ft. wide and 15 ft. deep, were dredged. This bottom width was necessary to allow ample space in which to land the pipe in the trench. A total of approximately 4 million cubic yards of dirt was moved during this project, with as much as 85,000 yd. in a single day—indicating the tremendous earth-moving possibilities of large dredges. Dredges were also used in various other crossings, among them the Missouri and St. Lawrence.

The approaches can normally be excavated with drag lines. In digging the approaches to a crossing, a long flat slope is desirable—thereby keeping the number of shop-made bends to a minimum. In addition to being difficult to place accurately, bends constitute a hazard for passage for the scrapers.

A departure from the dredge method of trenching was recently attempted on a crossing of the Hudson River between New Jersey and New York. A jetting arrangement was devised to provide the trench for a single 26-in. line going straight across. In this case the location of the site was restricted in choice because of the placement of a receiving terminal on the New York side. The Hudson River at this point has a silty, oozy bottom; and it was necessary to install the pipe about 25 ft. under the bottom for protection from dragging ship anchors, and to insure a stable position.

The jet consisted of a 30-ft. joint of perforated pipe attached beneath the first joint of line pipe and connected by hose to pumps mounted on a surface barge. It was planned to assemble the pipe in sections on one side and, with the jet on the front of the first section, to pull the sections in from the opposite side as fast as the jet could provide depth. For about 1,000 ft. this was accomplished; but soon some clayey deposits were encountered, at about the 15-ft. depth, which the jet could not displace.

With a deadline for completion not far off, it was decided to dredge the remainder of the job rather than to try another time-consuming experiment—which, because of unfavorable soil consistency, might not prove successful. The value of jetting is recognized when certain conditions are present; but it is limited to highly porous soils, and its worth is governed by the ability immediately to fill the displaced area with the object being buried.

On the St. Lawrence River, a straight-cross installation, winches on the dredge were utilized in pulling sections of line, from 800 to 1,200 ft. in length, from the shore into the stream. Assisting were tractors and side booms on shore, but the majority of the pulling power came from the dredge. No pontoons were used in this operation, but their use as a means of floating pipe over the trench is recognized. It might be mentioned here that an advantage of installing line straight across the stream is that successive strings of pipe can be pulled and/or pushed in place—thus minimizing handling. This is true up to certain lengths, but does not cover all crossings.

When an upstream or downstream catenary design is used, or when the crossing is so long that pipe cannot be pulled in, the pipe must be lowered in from floating equipment; it is well to take account here of the amount of equipment involved. In the aforementioned crossing of the Mississippi River the pipe, in 120-ft. sections, was loaded on one barge and towed into the stream, where a ramp barge was anchored over the pipe-line trench.

The pipe was transferred to the inclined ramp by a derrick mounted

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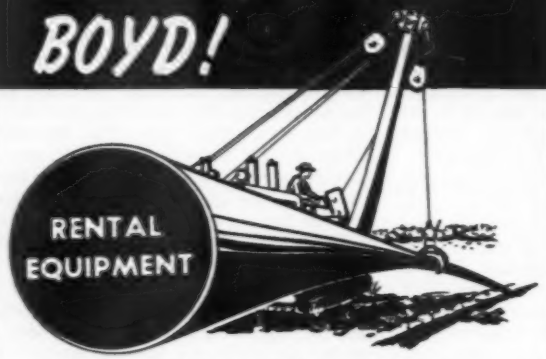

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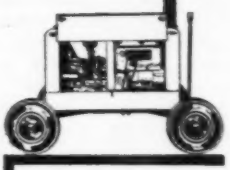

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on a third barge. After each section had been placed on the ramp and welded to the preceding section, the ramp barge was moved forward by tugboat and winches—allowing the pipe to slide down the ramp into the water. Three lowering-in barges were stationed astern of the ramp barge on about 70-ft. centers over the trench; and the pipe was lowered on a gradual slope—thus relieving stress from the pipe weight.

A recording fathometer, installed on a small boat following the last lowering-in barge, was used to determine that the line was actually coming to rest in the trench. As the completed line neared the shore, pipe was lowered from the side of the barge ramp rather than from the ramp itself.

Speed had to be maintained in this entire operation, as the trench began filling with silt and mud as soon as the dredging ceased. To emphasize the necessity of losing no time, 2 weeks after the pipe had been laid the river current had entirely refilled both trenches.

Inspecting and Testing

Inspection and testing are vital to the successful completion of a pipeline river crossing, and normally the owner furnishes inspectors for all phases—particularly pipe coating and welding. The welders who work on a river project should be the best available, and should be tested in advance for efficiency and workmanship.

Many companies now prefer X-ray welds. In fact, of six major river crossings studied, X-rays were used on all. This method obviously provides the most positive check for imperfection of welds; and, consequently the tendency to reinforce welds with sleeves is decreasing. Inspectors assure that the pipe or coating is not damaged during handling and installation, and that the line is placed in its proper position.

The fathometer mentioned previously has served a good purpose in indicating the final position of the pipe. Even though the operating pressure at points of crossings will often be less than 500 psi., practically all lines are given 1,000-psi. hydrostatic test.

For obvious reasons, locating engineers make every effort to avoid crossing sites which contain solid rock. It is true, of course, that sometimes there is no practical alternative, and in such instances the best must be made of a bad situation. Extra equipment for drilling, blasting, and removing rock is required; and additional precaution must be exercised in lowering in the line, as well as providing protection from the rock base and backfill by adding rock shields, earth padding, or both. One saving factor in most rock crossings is the extreme stability afforded the finished line.

Use of "Well Points" for Dewatering

In some parts of West Texas, Central Kansas, and Oklahoma, pipe-line-construction personnel have had considerable trouble with subsurface water at points of river crossings. In some instances the amount of water underground exceeds that in the surface stream, and "well points" have been employed in an effort to dry up the working area.

This method of dewatering has been used for some time in different construction work, primarily subsurface foundations and installations; but its use in pipe-line jobs seems to be fairly new.

A well-point system, in its simplest form, is a series of interconnected pipe, the points or bottoms of which pipe have been sunk into the ground to the approximate level of the strata which contain the water, and which are hooked up to a pump or pumps aboveground. These pumps pull the water up and discharge it to an out-of-the-way location. The size and depth of the system would depend, of course, on the amount of water to be removed and its subsurface location.

As a general rule, these systems have been installed in locations where it was particularly desirable to put

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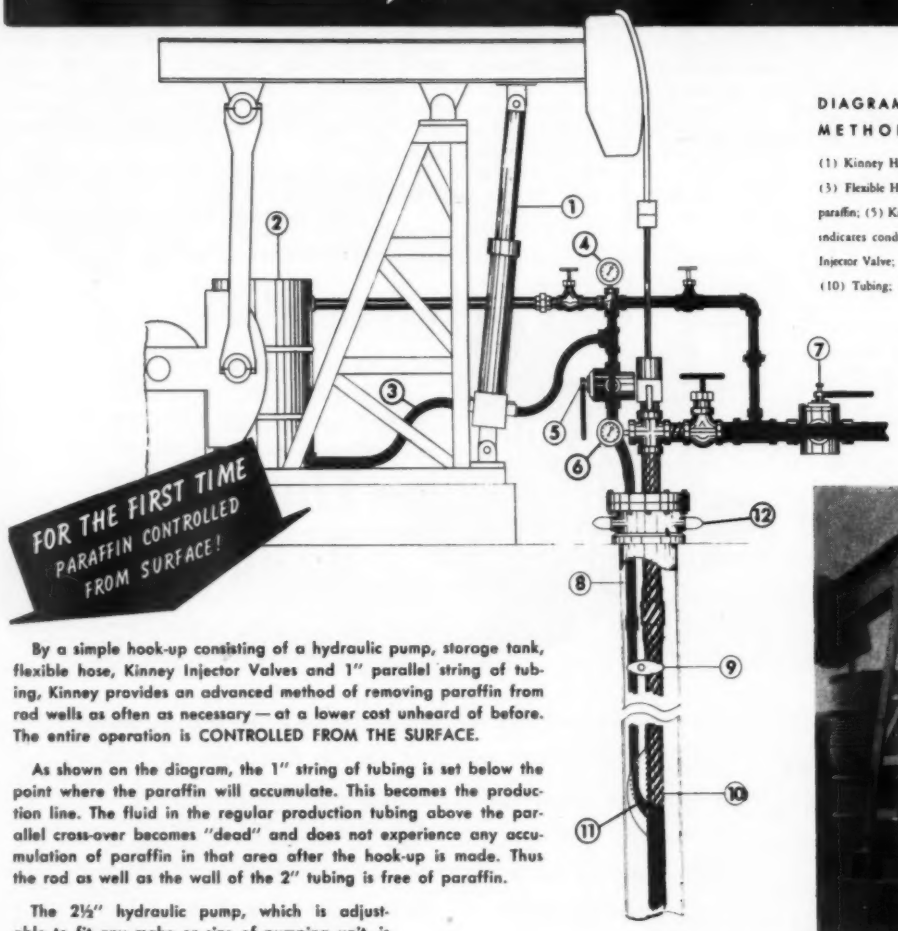

DIAGRAM OF HOOK-UP AND METHOD OF OPERATION

(1) Kinney Hydraulic Pump; (2) Supply Tank; (3) Flexible Hose; (4) Gauge, indicates removal of paraffin; (5) Kinney Plug Injector Valve; (6) Gauge, indicates condition of paraffin; (7) Kinney Plug Injector Valve; (8) 1" Tubing; (9) Parallel Clamp; (10) Tubing; (11) Crossover; (12) Parallel Head.

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As shown on the diagram, the 1" string of tubing is set below the point where the paraffin will accumulate. This becomes the production line. The fluid in the regular production tubing above the parallel cross-over becomes "dead" and does not experience any accumulation of paraffin in that area after the hook-up is made. Thus the rod as well as the wall of the 2" tubing is free of paraffin.

The 2½" hydraulic pump, which is adjustable to fit any make or size of pumping unit, is designed to operate only when injecting the plugs in the well. The connecting head of the hydraulic pump is easily engaged or disengaged by merely slipping or pulling it from a slot. When the pumping pressure builds up due to paraffin accumulation in the 1" production line it is reflected on Gauge, Figure 6. A Kinney Soluble-Mechanical Plug is injected in Valve, Figure 5; the Hydraulic Pump is connected to pumping unit, and the plug is forced down the tubing below the paraffin line but safely above the opening of the main tubing. When the hydraulic pump is cut-off, the pressure is then reversed and the plug carried up through the tubing and out into the flow line. This procedure is done as often as is necessary to remove paraffin without any shut-down of the well except when necessary to connect and disconnect the hydraulic pump. The entire system is complete and available for easy installation. Instructions for installing are furnished. Once installed all that is necessary to keep the tubing and flow lines free of paraffin is to insert the soluble-mechanical plugs at intervals. By reducing the load on pumping equipment caused by paraffin deposits, the Kinney Paraffin System cuts initial equipment costs, and cuts paraffin elimination costs as much as ONE-HALF each month.

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the pipe to an exact depth, and when it was felt that the cost of well-point installation was justified because it provided a water-free working area.

In many instances where small amounts of water are involved, a single line of 2-in. pipe on 2½-ft. centers is installed to the desired depth of the upstream side of the proposed work, and it is operated continuously during the work. When one line is not sufficient to handle the volume, an additional line or lines must be utilized—either parallel to the original pipe or completely surrounding the working site, depending on the source and the flow of the water.

Some users have reported worthwhile results from well points in areas where shifting sands are present—maintaining that, after the water had been removed, the tendency of the sand to "close in" on the excavation was minimized. Many builders say that the satisfaction of working under dry conditions, and of always being able to see the bottom of their pipe-line trench, is worth the price of a dewatering system. The use of points is, of course, most efficient when the surface water is negligible and can be diverted or removed—thus providing dry work from end to end and, for all practical purposes, eliminating river-crossing problems.

It must be remembered that the well-point idea is, in its original design, for conditions where subsurface water creates problems sufficient to justify water removal. It is taken for granted that this method for dewatering works best in sand and gravel, and least efficiently in nonporous formations such as clay. Inasmuch as the normal method of installing the system is to jet the small suction pipe to its desired depth, the presence of rock above the water level precludes any reasonable use of well points.

It is always possible, of course, to drill holes for the well points, but in most cases the expense would not be justified by the results.

Overhead Crossings

Mention should be made of another method of crossing water. Many rivers or streams with very deep beds, but not very wide, can be successfully and economically spanned by overhead means.

It is sometimes more practicable to do so using fixed supports or suspension-type "bridges" than to go under the stream. This type of crossing is usually at nonnavigable streams of widths less than 500 ft. However, there have been, and will no doubt continue to be, some instances where wide, navigable rivers with certain stream and bed characteristics—such as an extremely unstable bottom, high-velocity currents, and varying water levels—make the construction and maintenance of a submarine crossing impracticable. In such cases

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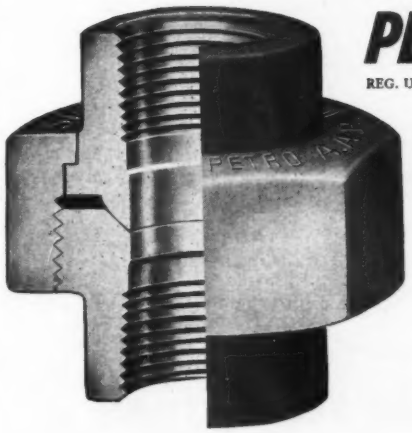

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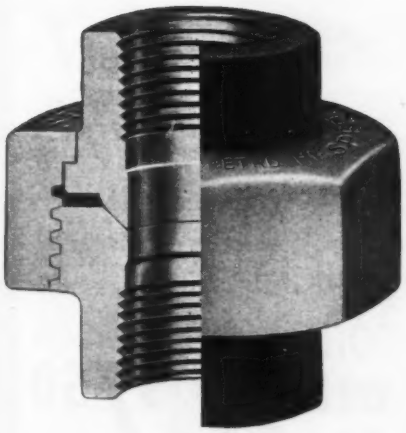

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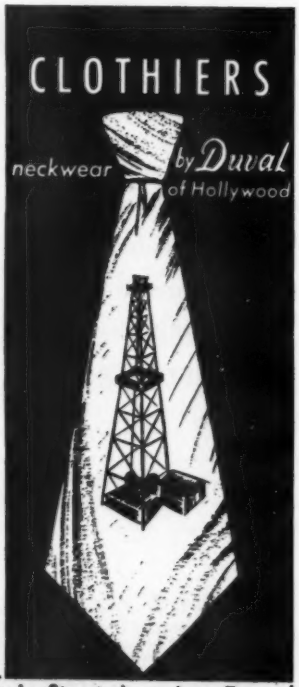

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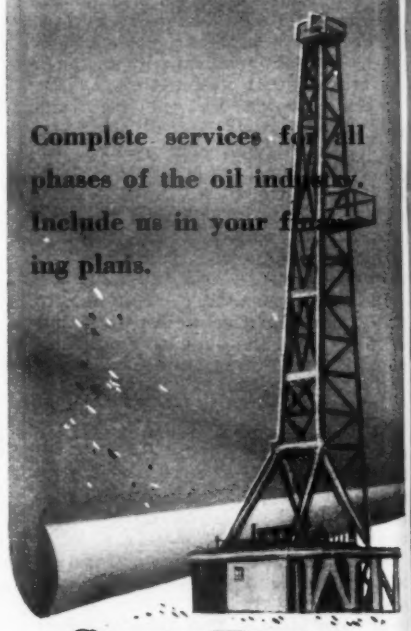

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elaborate bridging systems have been devised and employed, with considerable success.

The cost of installing an overhead crossing of a navigable river is usually so high (from 10 to 15 times that of under-water crossings) that most companies prefer submarine crossings. In many instances lines have been attached to highway and railroad bridges across rivers.

At Greenville, Miss., one gas company has practically bought a multimillion-dollar bridge across the Mississippi, on which it already has lines and is adding additional lines. Utilization of existing bridges, although no doubt practicable under certain conditions, is not widespread.

Conclusions

Although no two designers are likely to choose exactly the same methods, it seems that a majority agree on the following points:

1. The pipe for a river crossing should have a ½-in. minimum wall thickness, and should withstand a tensile yield test of 50,000 psi., with a carbon content not in excess of 0.30 per cent—preferably an average of 0.25 per cent.

2. Considering the value of a river crossing, the best coating is none too good; and the author believes that a somastic-type coating is best.

3. It is wise, in large-diameter lines, to add sufficient weight to provide about 20 per cent negative buoyancy. It is the author's opinion that a continuous-weight-covering is preferable to the clamp method.

4. When a river or body of water has very little or no current, the most practicable design is a straight line across. If the current is appreciable, an upstream or downstream catenary, or combination of the two, is favored. If dual lines are installed, they should be in separate trenches; and, if feasible, they should be far enough apart to prevent the loss of both, for a common reason.

5. If the pipe is to be laid straight across the stream, and if sufficient power is available, the easiest way to install is by pulling and/or pushing the pipe in successive strings. If this is a catenary design of any appreciable length, the pipe must be lowered in from floating equipment in straight sections short enough to allow the forming of the catenary after and during the lowering in. For wide, deep rivers, a dredge has proved itself to be the most practicable and dependable means of excavating the trench.

6. All available tests should be applied before the line is lowered in.

7. Never underestimate the power and danger from a river. Pick the best site available, and put the crossing in deep—bowed upstream, perhaps downstream, or straight across. Put it in coated or bare—weighted or not; but put it in deep!

Delivering Oil Products Is Big Business

PROGRESS.—About 10,000 tank trucks deliver gasoline, fuel oil, and kerosine. These trucks carry oil to and from about 30,000 bulk plants. Pipe lines, barges, and about 100,000 railroad tank cars—enough to form a train 700 miles long—also help supply the bulk plants.

400,000 Outlets Sell Gas

PROGRESS.—In addition to the 188,305 service stations which market gasoline, there are about 200,000 retail outlets for motor fuel in country stores, garages and similar establishments, it has been estimated. These assure drivers of the nation's 44 million motor vehicles a constant supply of motor fuel when they want it and where they want it.

"Cavities" Under Concrete Roads Filled With Asphalt

PROGRESS.—Petroleum asphalt, familiar through its use on road surfaces, is now being used under highways, too. Liquid asphalt, forced through holes drilled in concrete pavement, fills in cavities caused by water seepage. This prevents the pavement from cracking and collapsing. The holes are then closed to seal in the asphalt.

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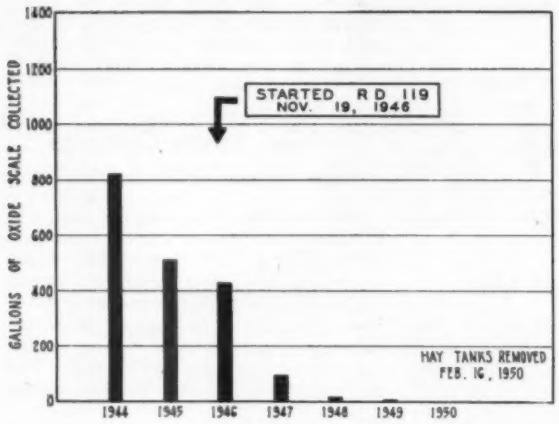

Fig. 1—Station 6, Bryan, Ohio, oxide scale removed from line.

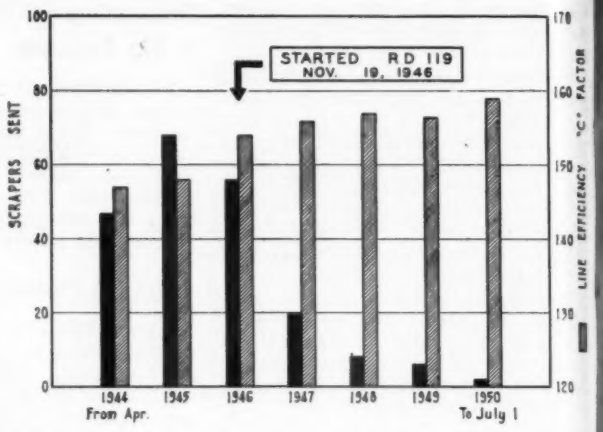

Fig. 2—Number of scrapers vs. line efficiency—8-in. pipe line from Station 4, Goshen, Ind., to Station 6.

New Corrosion Inhibitor Gets Job Done

Sinclair began using its RD-119 more than 4 years ago to prevent corrosion in the interior of products pipe lines. Highly satisfactory results are here reported

by K. T. Feldman* and F. M. Watkins†

SINCLAIR'S brand of rust inhibitor, RD-119, has been used for prevention of corrosion in the interior of products pipe lines for over 4 years. It was first added to products passing through pipe lines using Hills-McCanna pumps for the injection. After preliminary tests proved successful, the inhibitor was added to all distillate fuels at the refineries during blending of fuels to refinery specifications. More than a quarter billion barrels of distilled Sinclair fuels have now been inhibited.

Laboratory Control Tests

Amount of rust inhibitor added to Sinclair products for protection of pipe lines is now controlled by a modification of the A.S.T.M. Test D-665, tentative method of test for rust-preventing characteristics of steam turbine oils in the presence of water. For this purpose the test is run at 100° F. for 3½ hours with distilled water, following the prescribed ½-hour precoat period. All other requirements prescribed by A.S.T.M. are followed.

Results from this test correlate well with those obtained in pipe-line service in that substantially the same amount of rusted surface area appears on laboratory specimens as is observed on specimens after a 30-day field-test exposure. When this test is run and no inhibitor is present, a light rust forms on 75 to 100 per cent of the exposed test specimen's surface. When the laboratory test is run for a 48-hour test period coupons exposed in uninhibited fuels develop heavier rust films, whereas coupons exposed in inhibited fuels show little difference in total weight of rust film or total rusted area.

Enough inhibitor is added at the refinery so that no rust appears on 95 per cent or more of the test area. This requires 20 to 30 lb. of RD-119 per thousand barrels of distilled products.

Mechanism of Inhibitor Action

A considerable number of tests have been run to demonstrate the mechanism by which RD-119 prevents rust. In adsorption tests, dry iron powder adsorbed substantially the amount of this inhibitor required to form a monomolecular layer. In other adsorption experiments of this type, large amounts of inhibitor adsorbed on particles of rust. RD-119 is a neutral polar material, and it is therefore apparent that these polar molecules adsorb on metallic and on metal-oxide surfaces, thereby decreasing the tendency of water and of corrosive water solutions to wet and corrode.

Adsorption of this inhibitor on a metal surface can be demonstrated using the A.S.T.M. test described above. When test rods have been exposed to the mixture of water and products for 5 or 10 minutes and then removed, it will be apparent that water particles do not adhere to the rod tested in the presence of a rust inhibitor, whereas they adhere readily to the rod tested in the absence of a rust inhibitor. Water droplets do not adhere because a continuous insulating film of rust inhibitor has been deposited on the iron surface.

Both laboratory and field-test data indicate that RD-119 does not rapidly loosen and remove existing rust films as do some, more chemically active inhibitors. Rust films are often loosened by formation of new rust between a metal surface and an old film. New rust pries the old rust loose. RD-119 which adsorbs both rust and metal surfaces stops further corrosion and thereby slows down removal of old rust.

In laboratory tests, rust was formed in the presence of small amounts of RD-119. The test coupon was then continued on test in the presence of a normal amount of the same inhibitor and no change in the amount of rust was observed at the end of an additional 48-hour exposure period. In the field, RD-119 inhibited products were pumped into a converted crude line which still contained some rust and mill scale. These corrosion products gradually broke loose over a period of nearly 2 years.

Physical and chemical properties of RD-119 were discussed in a paper published in The Oil and Gas Jour-

*Sinclair Refining Co., Products Pipe Line, Marion, Ohio. †Sinclair Refining Co., Research & Development Department, Harvey, Ill. Summary of paper presented at American Petroleum Institute meeting of Subcommittee on Products Pipe Line Technology, St. Louis, September 1950.

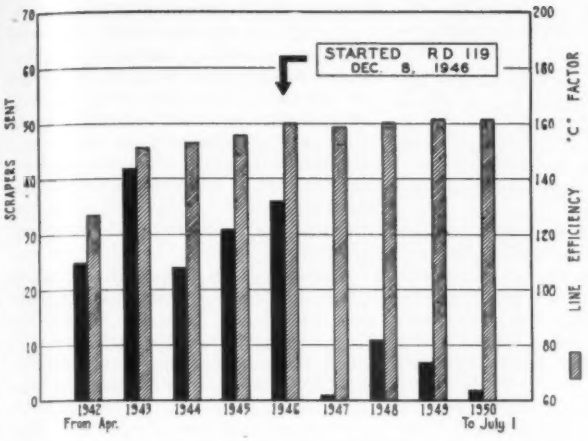

Fig. 3—Number of scrapers vs. line efficiency—8-in. pipe line from Marcus Hook to Shaefferstown, Pa.

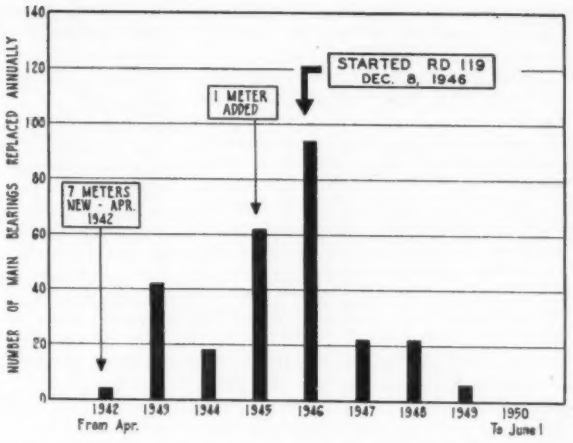

Fig. 4—Number of bearings replaced on 8 positive displacement meters at Shaefferstown.

nal of June 17, 1948.* This article gives evidence to prove that this inhibitor has substantially no effect on specification tests of distillate fuels, that is, gasoline, kerosine, or heating oils in which it is used. For ready reference, however, Table 1 shows laboratory tests on a recent batch of this nontoxic, liquid inhibitor.

TABLE 1—LABORATORY INSPECTION TESTS ON CURRENT PRODUCTION OF SINCLAIR RD-119

Laboratory tests—	Results
Gravity, °A.P.I.	27.9
Flash, °F.	250
Fire, °F.	375
Vis (S.U.S.):	
At 100° F.	213
At 210° F.	51.8
Color	8+
Pour	5

Advantages of This Type of Rust Inhibitor

Sinclair's RD-119 differs from pipeline inhibitors in use before 1946 in two respects. It is a stable product and it is soluble in distillate fuels. Though these two properties seem exceedingly simple, actually they have many advantages.

Since RD-119 is a stable product it may be added to distillate fuel once and once only, in contrast to those inhibitors which can be added to products only after they enter the pipe line. Many inhibitors must be continuously added to the pipe line at 75 to 100-mile intervals throughout the entire length of the line. This repeated inhibitor injection is particularly costly in long lines.

Since RD-119 is stable, it is not destroyed until the fuels in which it is blended are finally consumed. Products have been checked by our laboratories after passing through 100 to 800 miles of pipe line and after subsequent laboratory storage up to 1

*E. W. Unruh and F. M. Watkins, The Oil and Gas Journal, Vol. 47, No. 7, page 63 (1948).

TABLE 2—INSPECTION DATA ON TEST COUPONS SHOWING CORROSION RATING AFTER EXPOSURE—PENNSYLVANIA SYSTEM OF SINCLAIR PRODUCTS PIPE LINE

(Station 1 = Chelsea, 2 = Schaefferstown, 3 = York, 4 = Baltimore, 5 = Washington, 6 = Blain, 7 = Duncansville, 8 = Steubenville.*)

Month strip removed:	RD-119 gal. per	Station							
1946—	1,000 bbl.	1	2	3	4	5	6	7	8
August	2.64	..	B+	A	E	E	..	..	..
September	2.70	..	C	A	B+	B+	..	..	..
October	2.25	..	C	A	C	B+	C	E	C
November	1.93	..	E	A	A	A	B	E	E
December	1.91	..	..	A	A	B+	C	E	E
1947—									
January	2.08	..	A*	A	A	A	A*	A*	A*
February	2.30	..	A	A	A	B++	B	A	A
March	2.37	..	A	A	A	B	A	A	B
April	2.44	..	A	B	A	B	B++	A	..
May	1.83	..	A	B++	B+	C	A	B+	B+
June	2.44	..	B	A	B	B	B++	B	A
July	2.16	..	A	B+	A	B	B+	B	..
August	2.10	..	B++	A	A	B	B++	B	C
September	1.91	..	A	B+	B+	B	B+	A	B+
October	1.52	..	B+	B+	B	B+	B+	B+	B
November	†1.76	..	A	A	B++	B++	A	A	B+
December	....	..	A	B+	A	B+	B+	A	A
1948—									
January	....	..	A	B+	B	B+	A	A	A
February	....	..	A	B+	A	A	A	A	A
March	....	..	B++	A	B+	A	B++	B++	B+
April	....	..	B++	B	B++	B++	A	A	B++
May	....	..	A	B+	B++	C	A	A	B+
June	....	B+	B++	A	B+	B+	B	B	B+
July	....	B++	A	B++	B++	C	A	..	B+
August	....	..	A	B++	B	B+	A	B+	D
September	....	..	B+	C	B	B+	C	B	B
October	....	B+	B+	B+	B	B	B	B	C
November	....	A	A	A	B	C	A	B++	B+
December	....	A	..	A	B	C	B+	B	B+
1949—									
January	....	A	A	A	B++	B+	B++	A	A
February	....	A	A	A	B	C	A	B	A
March	....	A	A	A	B+	B+	B+	B+	C
April	....	C	A	A	B++	A	B+	B+	B+
May	....	A	A	A	A	B	..	C	B+
June	....	..	A	B++	B+	A	..	D	B+
July	....	A	C	..	C	B	C	C	C
August	....	A	B++	..	B+	B	D	C	E
September	....	A	B	..	C	D	B	C	D
October	....	A	B+	..	B	E	B++	D	D
November	....	..	..	..	..	..	..	..	..
December	....	A	A	A	B++	B+	A	B++	B
1950—									
January	....	A	A	A	A	A	A	B++	B
February	....	A	A	B++	A	C	B+	A	A
March	....	A	B	..	B+	B	B	B	B+
April	....	B++	B+	..	B++	B+	B	B+	B+
May	....	A	A	..	C	B+	B+	A	C
June	....	A	A	..	B++	B	..	B++	C

Rating scale: A—perfect, no rust. B++—A few pinpoints of thin rust. B+—Several spots of very light rust. B—5 to 25 per cent of surface area covered with light rust. C—25 to 50 per cent of surface lightly rusted. D—50 to 75 per cent of surface rusted. E—75 to 100 per cent of surface rusted.

*Stations designated were protected by inhibitor after December 1946. †Inhibitor was blended with products by refinery after November 1947.

year, and the inhibitor content remained constant as far as could be detected by our tests.

Isolated samples have been analyzed from which part of the inhibitor has been removed by adsorption on water droplets, metal surfaces, or rust particles, some of them from tanks which had not held RD-119 inhibited products before. Whereas adsorption of inhibitor was found to reduce its concentration in the fuel, the extracted inhibitor soon saturated the new surfaces and subsequent batches of products then contained a normal inhibitor content.

Solubility in distillate fuels has many advantages. Product solubility allows this material to be blended in a refinery where equipment for handling a liquid inhibitor is usually already available. Addition of the inhibitor at the refinery also extends its rust-preventive properties to refinery equipment. Refinery-blended products are checked by refinery laboratories where control tests are most accurate and least expensive. Then all shipments can be closely controlled to exacting specifications before products are delivered to pipe lines or consumers.

Product-soluble inhibitors do not drop out in a separate water phase in the bottom of the pipe lines or in the bottom of the first storage tank they enter nor do they require an extraneous water phase with all its objectionable characteristics. They have the advantage of being present at any product covered surface whereon moisture condenses, whereas water-soluble inhibitors are present only at the bottom, except in a line where turbulence is great enough to suspend droplets of inhibited solution throughout a product.

Pipe liners are constantly plagued with many minor annoyances from extraneous water. Partial separation of a water phase occurs in pockets throughout a pipe-line system. These pockets of water restrict the free cross-section of product and add to the pressure drop throughout the line. At low winter temperatures, water solutions crystallize and resulting ice plugs cause even greater friction losses. Crystallization can be overcome by using high salt concentrations or by adding alcohols to reduce the freezing point. Finally, water and inhibitors dissolved therein must be completely separated before products can be delivered to consumers. Though each of these objectionable characteristics is minor in itself, the total is great enough to strongly recommend use of a product-soluble inhibitor.

This paper is primarily concerned with advantages to operators of products pipe lines from use of RD-119. However, some of the benefits which have accrued to others from use of RD-119 in distilled fuels may also be of interest. One branch manager reports that rust has disappeared from the inside of transport truck tanks since RD-119 was added to light oils. This observation checks an extensive series of tests run on twelve 8,000-gal. tank cars over an 8-month period before RD-119 was added by the refineries. At the end of the test, an average of 2.6 lb. of rust was removed from each of the eight cars which had carried inhibited products. An average of 14 lb. of rust was removed from each of the four cars which had operated on uninhibited fuels under the same conditions. In these tests, the inhibitor reduced observed corrosion products by 80 per cent.

One company's construction and engineering department reports that since it has handled rust-inhibited gasoline, there has been a major decrease in the number of bulk-station and filling-station tanks which required cleaning. Corrosion appears to have stopped in bulk-plant fuel pumps and fewer worn-out filling-station pumps have been reported for repair. Also, deposits on filling-station screens substantially disappeared soon after inhibited gasoline was received.

A group of 20 automobiles was inspected after a 1-year test. Half of these operated on inhibited and half on uninhibited gasoline. At the end of the test no active corrosion was found in carburetors, pumps, or tanks of those cars which operated on rust-inhibited gasoline. Corrosion was found in some fuel pumps which had operated on uninhibited gasoline. Corrosion products were found on pump screens, but deposits on screens operating on uninhibited gasoline were appreciably greater than those operating with inhibited gasoline. One motor-vehicle department reported a 75 per cent reduction in carburetor and fuel-pump replacements since it has operated on inhibited gasoline.

TABLE 3—INSPECTION DATA ON TEST COUPONS SHOWING CORROSION RATING AFTER EXPOSURE—CHICAGO-TOLEDO LINE OF THE SINCLAIR PRODUCTS PIPE LINE

(Station 1 = East Chicago before inhibitor, 2 = East Chicago after inhibitor, 3 = Wheeler Sta. 2, 4 = Goshen Sta. 4, 5 = Bryan Sta. 6, 6 = Toledo Sta. 8, 7 = Detroit Term., 8 = Clinton Term., 9 = Columbus Term.)

Month strip removed:	RD-119 gal. per	Station								
1947—	1,000 bbl.	1	2	3	4	5	6	7	8	9
February	2.10	E	B++	C	B+	B+	B+	..	..	..
March	2.55	E	B++	C	B+	B+	B+	..	..	..
April	2.41	E	B++	A	A	B++	B++	B+	..	..
May	2.48	E	B++	A	A	B++	B++	B+	..	..
June	2.48	E	C	A	B++	B+	B+	B++	..	..
July	2.66	E	C	A	B++	B+	B+	B++	..	..
August	2.35	E	D	A	B++	B+	B+	B++	..	C
September	2.10	E	D	E	A	A	B+	E	..	D
October	2.20	E	D	E	A	A	B+	E	..	D
November	2.71	E	D	B++	B+	..	A	A	..	B++
December	2.23	D	B+	B++	B+	..	A	A	..	B++
1948—										
January	1.10	C	B++	A	B++	B++	A	B++	..	A
February	1.41	..	..	A	B++	B++	A	B++	..	A
March	....	D	B++	..	..	..	..	..	..	..
April	2.79	E	C	C	B	A	D	A	..	..
May	2.59	E	C	B+	B++	A	A	B++	A	A
June	2.29	E	C	B+	B	B+	A	A	A	A
July	(*)	D	C	B	B++	B++	A	B++	..	A
August	....	E	D	B+	A	B+	B++	A	..	A
September	....	E	D	..	A	A	B++	B++	A	A
October	....	E	D	..	B+	C	A	B++	B+	A
November	....	..	..	..	B	B	A	A	A	A
December	....	..	..	..	B	B	A	A	A	B
1949—										
January	....	..	..	B+	A	A	A	A	A	A
February	....	..	B	B+	A	A	A	A	A	A
March	....	..	B	B++	..	A	A	A	B	A
April	....	..	A	A	C	A	A	A	A	A
May	....	..	..	..	B+	A	A	A	A	A
June	....	..	A	A	A	A	A	A	A	B++
July	....	..	..	A	A	..	B+	B+	..	A
August	....	..	..	..	A	..	A	..	B+	..
September	....	..	..	B+	B++	B	A	B++	A	A
October	....	..	..	B+	A	B++	A	B+	B+	A
November	....	..	..	B++	B+	A	A	..	A	B++
December	....	..	A	A	B	C	B+	A	A	A
1950—										
January	....	..	..	A	..	A	B++	A	..	A
February	....	..	..	A	A	A	B++	..	B++	A
March	....	..	..	A	A	B	A	A	A	A
April	....	..	..	A	A	B	A	A	A	A
May	....	..	..	A	B++	A	A	A	A	A
June	....	..	..	A	A	A	A	A	A	A

Rating scale: A—Perfect, no rust. B++—A few pinpoints of thin rust. B+—Several spots of very light rust. B—5 to 25 per cent of surface area covered with light rust. C—25 to 50 per cent of surface lightly rusted. D—50 to 75 per cent of surface rusted. E—75 to 100 per cent of surface rusted.

*Inhibitor added by refinery.

Pipe Line Experiences and Test Results

Upon completion of favorable laboratory tests to determine the rust-inhibitive qualities of RD-119, it was decided to make actual operating

tests in the products pipe lines of Sinclair's Pennsylvania district.

Injection of RD-119 was begun at Schaefferstown on July 24, 1946, in the 136-mile 6-in. Baltimore and Washington line. Schaefferstown was chosen as the initial injection point since injection could be made to one outgoing line and its operation compared to the other 6-in. uninhibited line. Another commercial inhibitor had been used throughout this system since 1944, but was discontinued three weeks prior to initial injection of RD-119.

In order to test the effectiveness of RD-119, polished steel test coupons, approximately 5 by ½ by 1/16 in., were installed in the products stream, both upstream and downstream from the RD-119 injection point. Test coupons were maintained continuously in the line 1 month before removal.

Test coupons are very sensitive for evaluating the effectiveness of an inhibitor, and they frequently show more rust than actually forms in the line. Moisture or accidental contact with the operator's hands during the insertion of test coupons into the line will cause slight specks or films of rust to form which immediately lower the rating of the coupon. Test coupons may also show more corrosion when they are dropped into an inactive line. Water touches and rusts the clean coupon surface before inhibitor forms the protective film.

Some coupons removed from the line indicated that handling had not been perfect, but the ratings shown in Tables 2 and 3 reflect the actual condition of the test coupons as they were removed from the line. The test coupons installed ahead of the injection station at Schaefferstown and those installed in the uninhibited Steubenville line in 1946 became severely corroded, while the test coupons in the inhibited section remained almost entirely free of any rusting.

During the initial injection period from July to November 1946, the efficiency of the Baltimore-Washington line remained substantially constant while that of the uninhibited sections dropped 4.6 per cent. The excellent results obtained on the inhibited section and the reduced efficiency on uninhibited sections of the line led to use of inhibitor in the entire system.

Injection of RD-119 was started in the Chicago-Toledo line at Station No. 1, East Chicago, Ind., on November 19, 1946. A temporary injection pump was set at Toledo station, and all working storage on hand was inhibited as used to supply Detroit and Columbus. All injections of RD-119 at Toledo were completed by February 1947. Test coupons were installed at important locations and test results are shown in Table 3.

Injection into the Marcus Hook-Schaefferstown line at Marcus Hook was started December 8, 1946, and the inhibited stream was being received at Schaefferstown station when injection at Schaefferstown was stopped. After February 1, 1947, RD-119 was injected at only two points, East Chicago and Marcus Hook, on the entire eastern division.

All stations in the eastern division were originally constructed with "hay tanks" to trap oxide scale that was carried in suspension by the stream and brought into stations by scrapers. The inhibitor originally used improved the line efficiency, but required continual scraping of line to maintain a high efficiency with accompanying large amounts of oxide scale collected.

The record from Station No. 6, Bryan, Ohio, was chosen as a good example of oxide scale removed from the line as shown in Fig. 1. Year 1944 reflects the large amount of dirt and scale collected from any new line. Years 1945 and 1946 show a reduction in scale collected, but reflect the large amounts of oxide scale brought in, despite the fact that an inhibitor was being used. Years 1947 and 1948 show the large reduction in oxide scale after injection of RD-119 rust inhibitor. The amount of scale collected in 1949 was practically negligible and on February 16, 1950, the hay tanks were removed to reduce contamination to a minimum.

Further evidence of the elimination of nearly all rusting was indi-

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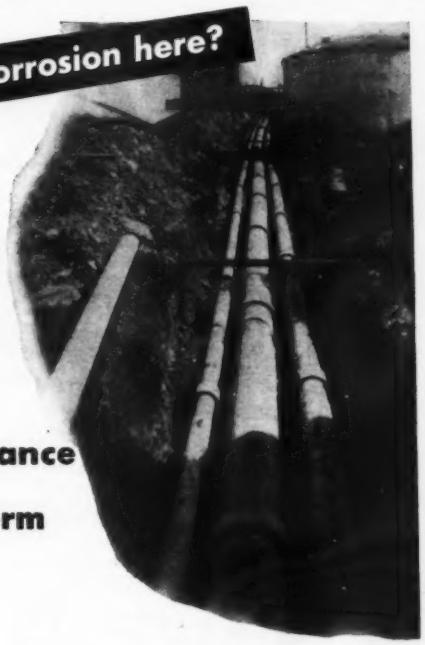

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cated by the amount of oxide scale brought in with scrapers. Before using RD-119, it was necessary to clean the hay tanks after scrapers had been received, and remove several wheelbarrow loads of oxide scale from hay tanks. After injecting RD-119 for slightly over 3 years, scrapers cause only a momentary clouding of the stream.

Another criterion for judging the effectiveness of RD-119 is the comparison between line efficiency using "C" factor as a measure, and the number of scrapers run through that section of line. This information is shown graphically in Fig. 2 on the 67.4 miles of 8-in. line between Station No. 4, Goshen, Ind., and Station No. 6, Bryan, Ohio. The number of scrapers through this section of line has been reduced from 68 per year in 1945 to 6 in 1949, or a reduction of 92 per cent, with an increasing line efficiency from a "C" factor of 150 to 156.5 or an increase of 4.3 per cent in line capacity. The line efficiency has further increased to a "C" factor of 159 in 1950. This is equivalent to an increased pumping capacity of nearly 1,000 bbl. per day.

"C" factors were calculated with gasoline through the entire Chicago-Toledo line and quantities were based on a 24-hour tank decrease at Station No. 1 converted to 60° F. This pipe was second-hand lap-weld pipe originally laid in crude service in 1929. It was taken up, reconditioned, and installed as a war project in 1943.

A similar graph showing the number of scrapers run annually and the line efficiency for the section of line from Marcus Hook to Schaefferstown is shown in Fig. 3. The "C" factor has steadily increased from an average of 124 observed during the first year of service to a maximum of 161.5 during 1950.

A large number of scrapers were required from 1942 to 1946 to maintain a high line efficiency even though a commercial inhibitor was being used. Since 1946 the "C" factor has increased from 160 to 161.5 with relatively few scrapers being run. The maximum efficiency of 161.5 "C" factor is somewhat higher than for the Chicago-Toledo line. The seamless pipe in this section probably has a smoother inside surface.

The maintenance of equipment coming in direct contact with the product stream has been much easier since RD-119 has been used as a rust inhibitor. Field mechanics report that the reduction of abrasive oxide scale in the stream has very definitely increased the life of mechanical seals, packing, and wear rings in centrifugal pumps. Erosion and replacement of pump impellers has been reduced at least 50 per cent. The main bearings of eight positive-displacement meters at Schaefferstown were being replaced at the rate of one per month in 1946, as shown in Fig. 4. Replaced main bearings were reduced from 92 in 1946 to 22 in 1947, or an increase of over 400 per cent in service life.

As a products-pipe-line rust inhibitor, RD-119 has definitely proved effective. RD-119 is nontoxic, is readily soluble in petroleum products, and offers no injection problems. Intermediate injection points have been eliminated, and inhibitor costs materially reduced. Oxide scale removed from the pipe line has been completely eliminated and hay tanks have been removed to reduce contamination to a minimum. Number of scrapers run have been reduced from two every 10 days to two every 6 months, with a 2 to 4 per cent increase in line efficiency. Maintenance and repairs on pumps and meters have been reduced 50 per cent. RD-119 is now being used in 2,800 miles of 3, 4, 6, 8, and 10-in. Sinclair products pipe lines and is injected in all refined distillate fuel products at the refinery, as part of the manufacturing procedure.

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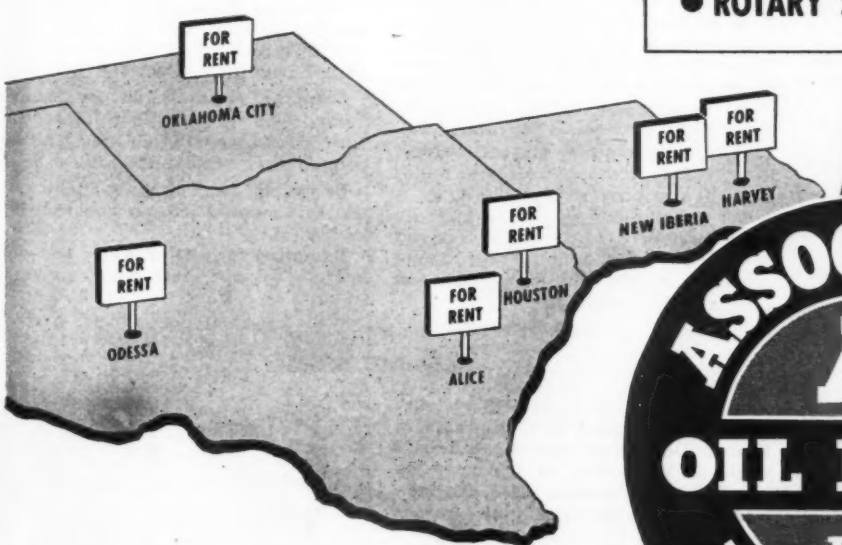

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XUM

How to Improve A.P.I. CODE 25

by G. H. Supple and Charles Nicholson

THERE is almost unanimous agreement on the point that there is a need for standardization of methods of measuring, sampling, and testing crude oil. The appointment of the new "Committee on A.P.I. Code 25" and the assignment to it of its responsibilities constitute evidence that the American Petroleum Institute as a whole affirms its belief in the worthwhileness of this endeavor. Here is the vehicle for concentrating efforts toward standardization of these procedures. Members of all A.P.I. divisions should avail themselves of this means for expressing their wishes in this field.

The committee has had to study carefully the scope of its responsibilities and the limitations of its authority. Some of these limitations are to be found in general A.P.I. policy.

The job of this committee looks like a formidable one. There should be no surprise if the final result is a combination of compromise and scientific fact; of recommended accurate procedure, with some permissible variations therefrom. Reconciliation of diverse views into an acceptable statement of recommended procedure will call for ingenuity, patience, and tolerance. Furthermore, this code will require constant attention to keep it abreast of newly developed requirements. This is so because it is related to a dynamic rather than a static industry.

The extremely short time since the appointment of the new committee has precluded the possibility of even making a complete survey of the job to be done. However, many have reported current practice to the chairman of the committee, so that some generalizations can be made regarding what the job appears to be at this stage. The following comments are based on a comparison of reported current practices of certain companies with A.P.I. Code 25.

Part 1—Tank Measurement and Calibration

With respect to determination of tank depth and circumference, those who have reported current practice quite generally follow A.P.I. methods. There are some deviations, but these deviations apparently are the result of practical considerations rather than on the basis that company methods are considered superior to A.P.I. methods.

All reporting companies follow A.P.I. method in determination and reporting of deadwood. A number of members suggest that additional data on floating-roof measurements should be included.

Some other suggestions include in code the basic principles of the calculation procedure. Tapes should be checked against master tape, with both tapes in vertical position, and at 60° F. rather than at 68° F.

Part 2—Gaging, Sampling, and Testing Crude Oil—General

Outgage method. — Most reporting companies do not mention this method. The few who do, follow A.P.I. with minor deviations.

Innage method. — Deviations here consist principally in latitude allowed from the ⅛ in. called for in certain size tanks.

Suggestions.—The code should more specifically describe the two methods.

The code should give specifications for plumb-bob size and weight.

Tank temperatures.—Field practice reported indicates that operators have very generally divided field tanks, as regards size, into two classes, viz., those up to 1,000-bbl. capacity and those above 1,000-bbl. capacity. There is a widespread belief, apparently, that tanks between 1,000 and 5,000-bbl. capacity require, or merit, closer attention to temperature determination than is provided by the code. A wide acceptance could undoubtedly be secured if the code were changed to specify more temperature determination points for tanks between 1,000 and 5,000-bbl. size.

Suggestions.—Size of cup on cup-case thermometer should be more specifically set up.

Gravity.—Here is one job on which we all seem to agree with the code. No suggestions.

Water and sediment.—There is a wide diversity of practices in this operation. It would seem that most of these are based on practical field considerations as against the more rigid requirements of the code. Reports thus far received give indication that this point will be a tough one for the committee. This is apparent since suggestions cover a wide range—from one which would allow no deviation from A.S.T.M. D96 to others which would like different sized tubes, different heating requirements, changed centrifuging periods, and a listing of permissible variations in diluents.

Sampling from tanks by thief.—One is tempted to say that there is almost complete lack of uniformity in this process. One-third of the reporting companies follow A.P.I. Code 25. The other two-thirds either do not use the method at all or seem to employ almost every conceivable variation. Promulgation of a standard which will be accepted and used by a satisfactorily high percentage of operators would seem to be a major project in itself.

Sampling from tanks by bottle.—Half of the reporting operators do not use this method. Of those who do, 90 per cent follow A.P.I.

Sampling from tanks by sample cock.—This method seems to be confined to one geographic area, and the companies in that area follow A.P.I.

Sampling from lines.—Those who use this method (50 per cent) all follow A.P.I.

Sampling for settled water and sediment.—All operators who commented follow A.P.I.

THE AUTHORS

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G. H. SUPPLE

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This paper was presented at the thirtieth annual meeting of the A.P.I., Los Angeles, November 9-17.

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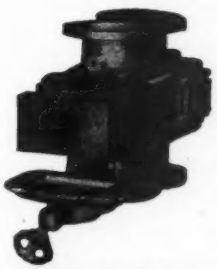

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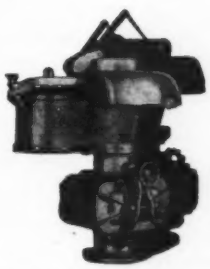

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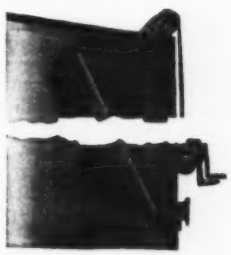

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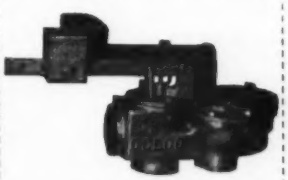

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XUM

OIL, GAS, *and the* BANKER

by F. F. Florence

What does the banker think of the oil industry? Here's a frank answer by one who is in an excellent position to know whereof he speaks.

SINCE the Lucas discovery at Spindletop in January 1901, the United States has produced in excess of 37 billion barrels of oil—two-thirds of the world's output. Historically, we can ascribe such accomplishments to fortuitous circumstances and individualistic thinking.

Whatever the cause, an industrial empire was built; and now, from the present point of vantage, we can view in retrospect the emergence of the great petroleum industry to its enviable position. Of the 25 largest manufacturing companies in this country, based on reported total assets of some 29 billion dollars, your industry represents approximately 45 per cent of this total. Furthermore, a recent study of our leading corporations shows that, for 1949, the petroleum group was by far the largest in respect to book net assets and capital investment. Following, in order, were iron and steel; then autos and trucks, including parts; but the petroleum industry represented a greater investment than the combined steel, motor, and electrical industries. With such growing industrial power in our possession, World War II was won.

Natural Bigness of Industry

The very nature of the oil industry in its relation to our national defense and economy—and, in the light of our use of it in World Wars I and II—requires bigness. Its bigness is a most important element in our national security. To penalize bigness of the industry might impair the adequacy of our national security in times of an emergency. The industry must be viewed with the welfare of all of our people in mind, and not from political motives.

At the beginning of 1950 the estimated proved crude-oil reserves of the United States were 24,648,489.000 bbl. The total liquid hydrocarbon reserves, including natural-gas liquids, were 28,378,501,000 bbl. Because I am from Texas, the question is often asked me: "Is it true what they say about Texas?" When I observe of the foregoing figure the State of Texas was credited with 13,509,732,000 bbl. of crude-oil reserves, I zealously reply: "Yes, many of those fabulous stories are true."

Although we, as bankers of the Southwest, are striving diligently to herald the financial and industrial growth of our respective communities, we fully realize that the relative ease with which we progress is attributable to the greatest assistance and support of all—the petroleum industry. Statistically, every sixth person in our state, one way or another, depends upon a livelihood from this industry—which, during 1947, spent more than 2¼ billion dollars in Texas alone; and, it migh be added, the petroleum industry pays more taxes than any other group.

Depletion Allowance

It is quite patent, therefore, that our general economy may be adversely affected by any circumstances injurious to the oil and gas industry. A case in point was the recent controversy over the 27½ per cent depletion allowance. Irrespective of subsequent developments on the world-wide scene, the decision of Congress to make no amendment to that allowance was indeed both logical and sound. In the light of current and increasing over-all costs of discovering oil, the present depletion allowance is fundamentally sound, necessary, and justified.

Despite the parlance of the oil man which classifies pipe-line checks as "income," he is well aware that capital depletion is operative; and, without proper and equitable consideration of this factor, the exploration stimulus will be mainly lost. Yes, with our growing crude demand climbing toward approximately 7 million barrels daily, we need oil, and every effort should be exerted by our banking fraternity to finance constructive development programs, and to maintain the progress of the industry.

All producers of oil and gas view with alarm the many attempts on the part of the federal Government to revise, if not to eliminate entirely, the allowance of depletion for income-tax purposes (both on a cost basis as well as statutory). It is important that such efforts of those in Government be held in check; otherwise, I am afraid, the entire industry will be placed in jeopardy.

The same is true with reference to permitting, for tax purposes, the deduction from income of intangible costs incurred in drilling.

Both the allowances for depletion and intangibles have a serious and material effect in turn upon the entire picture of finance with relation to the oil and gas industry. Without these highly justified allowances, it is my opinion that the financial institutions of this country cannot look upon oil and gas financing in such a favorable manner. All of us know the hazards of the business, and the growing costs of exploration and deeper drilling, which can be carried on only as a result of the depletion and intangible allowances. Without them, the oil and gas business could become stagnant, unable to attract further risk capital or the financing of development of proved reserves—both of which are so inherently necessary to the successful production of oil and gas and to the discovery of new reserves.

If they take away or decrease these allowances, they will destroy the ability of many producers to finance, and by removing that ability, they will strangle—and might well cripple—a vital industry and its products upon which our whole economy and defense efforts must rely. Therefore, any such proposals by those in the federal Government make your problems the banker's

THE AUTHOR

Fred Farrel Florence is president of the Republic National Bank, Dallas. His career began in 1907 at Rusk, Tex., and in 1915 he was made president of the Alto, Tex., State Bank, which city he served as mayor following World War I. In 1920 he was elected first vice president of Guaranty Bank & Trust Co. of Dallas (now Republic National) and in 1929 was made president. He is a director of several other Dallas banks, and of Missouri-Kansas-Texas Railroad Co.

This paper was presented at the A.P.I. thirtieth annual meeting, Los Angeles, November 9-17.

problems, and the problems of all thinking people; and we should exert all our forces to defeat such illogical proposes and dangerous practices by our Government.

It would be contrary to the public's interest to change these particular provisions. The risk of its effect upon our economy and national defense is far too great to have it confused with the additional tax dollars it erroneously assumes could be raised. It would be likened unto "killing the goose that lays the golden egg." I have faith that the patriotism and intelligence of our succeeding congresses will continue to preserve for the industry, and for our country, those provisions which encourage and justify the further exploration of oil and gas for the use and benefit of all of our people, and for our own national defense.

Gains by Natural Gas

Until a few years ago we did not fully recognize what great importance the gas industry would assume in our industrial system. However, there was a modicum of justification for this state of mind, for so often did we look upon the disappointed expression of oil man whose well resulted in gas. There was no market for the product, and the well was shut in; and, of course, casing-head gas was generally being flared.

It is true that the natural-gas business is one of our oldest, but only in recent years has its most rapid growth been reflected. Estimates now indicate a reserve in excess of 180 trillion cubic feet—more than two and one-half times that existing at the outbreak of World War II. And, again, Texas is most fortunate in having more than one-half of this reserve.

The industry has been most effectively stimulated by these increased reserves, together with the construction of our well-known long-distance transmission lines. But it is in the competitive field that gas has received its major impetus; there is now a market. Over the past 5 years retail prices for mineral fuels have shown a marked change—bituminous coal rising 50 per cent and natural gas 15 per cent. Where it is available, natural gas is seemingly the cheapest fuel; and though, certainly, I shall not attempt to prognosticate, at the moment there is no apparent indication that the favorable trend now being experienced by natural gas will undergo any early change.

Oil Legislation

Legislation in tremendous volume has been ground out at Washington over the past decade or two, most of which has placed further and further restrictions upon business. Some of this legislation has harmfully placed controls upon the oil and gas business, although part of it has been helpful—such as the commonly called "Connally Hot-Oil Act." Similarly, the Interstate Oil Compact Commission is rendering conspicuous service to the public, and to the oil and gas industry, by promoting and sponsoring state legislation and regulations to prevent physical waste of this great natural resource. This agency provides for the necessary interstate exchange of data and information, making federal intervention unnecessary and wholly undesirable.

On the other hand, there was one important bill before Congress which, in my opinion, should have become a law; it would have been in the best interest of our country. That was the so-called Harris-Kerr bill.

The gas producer is now subject to the acts of the Federal Power Commission, and, although the staff of the commission might be fair in its attitude now, the membership will necessarily change from time to time. With the power to fix prices on gas produced from each well, you can imagine what might occur. Can the commission determine the exact cost of each well, its producing life, the quality and quantity of gas, the expense of production in the future, the future cost of labor and material, the exact reserves of gas, and cost of boosting and compressing? Yet all of these factors must be absolute, and must be determined before the cost of the produced gas is known. And, before a fair price can be established, can and will a commission in Washington determine these factors? And how does that affect the banker? It would be impossible to estimate the value of a given property preparatory to financing without knowing what might happen as a result of some decision of a commission.

Legislation similar to the Harris-Kerr bill would permit gas to seek its market; and, with a given market, a financial institution could then establish basic values, looking toward financing the development and recovery of valuable and highly useful reserves. It is hoped that the next Congress will carry forward the purpose of the Harris-Kerr bill.

Oil and the Banker

Now, what does the banker think of oil and gas, and what does he do about it? As a profession, banking perhaps was slow, if not somewhat reluctant, to recognize oil and gas as a medium of financing.

Reputedly, the banker is cautious, and properly so. He had heard of the "wildcatter," the "plunger," and the "speculator." Had not the competent geologists raised questioning eyebrows at East Texas, and who was this Dad Joiner and his Daisy Bradford No. 1? That was not an unnatural reaction, inasmuch as the industry, as we know it now, had not become stabilized; and only with the advent of conservation did we see the possibility of applying an acceptable lending pattern. Therefore, it may be stated that the general utilization of banking and financial facilities by the oil man is to be dated from the discovery of the East Texas oil field and the application of sound conservation and proration practices arising therefrom. Indeed, prior to that time, the larger companies had received customary financial support in the East and elsewhere, but it was not until the early 1930's that banks in our section became interested in the so-called "production loans."

With personal knowledge of the ability and integrity of the operators, the commercial banks accepted their responsibilities, and in 1933 our institution began to pursue an active and vigorous interest in the financing of the petroleum industry. In the years following many other financial institutions throughout the oil-producing areas began to take their place in oil and gas financing.

The characteristics of oil and gas lending as such that this lending cannot intelligently, soundly, and safely be carried forward under normal commercial banking procedures, but requires trained and experienced organizations which are able to analyze and appraise the many complex situations involved therein. Our experience in dealing with the industry has been uniformly good, and we have made loans aggregating hundreds of millions of dollars.

The accepted practices of financial quarters for financing oil and gas have been so thoroughly worked out, both from a scientific and practical standpoint, that I am quite frank in saying that we believe we know more about our oil and gas loans intrinsically than we do of any other type of lending presently pursued by commercial banking institutions.

Industry Has Sound Credit

The large life-insurance companies of our area, and throughout the nation, have recognized the desirability of financing the industry. In many cases they have worked very closely with important banking institutions in the oil and gas areas—and with benefit to themselves in doing so. As a consequence of the good experience of financial quarters thoroughly organized to handle this type of business, oil and gas credit has become recognized as one of the soundest and most liquid which is presently available to commercial banking institutions and to insurance companies. Whatever might be the lending policies of these institutions, there is now a disposition among practically all substantial financial and investment quarters to have a part of their loan portfolio in oil and gas. This has the effect of making available to the industry a great reservoir of credit, which is being

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Automatic Dial telephone service that *you own and control*. Expands to any number of instruments, for any distance. Terminate your own circuits at P-A-X automatic switching centers for better service, lower operating cost.

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Multiply the capacity of existing circuits with Lenkurt carrier from Automatic Electric. One physical circuit can simultaneously carry telephone conversation, telegraph or teletype messages, and remote control impulses. Transmission is even more free from interference and noise than over physical wires.

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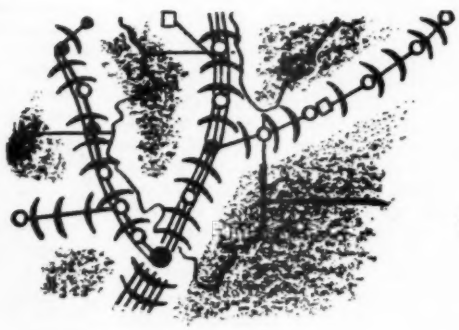
Automatic Electric telephones are especially adapted to the conditions of pipeline and oil industry installation. Explosion proof instruments, special handsets and portable telephones, as well as standard types are all in Automatic Electric's complete line.



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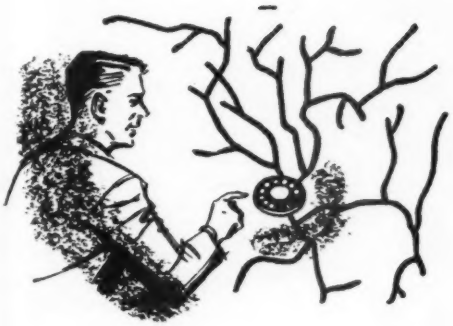
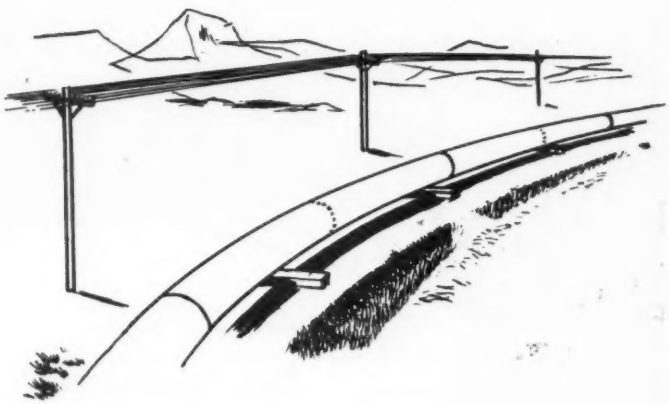
Automatic Electric telephone equipment can provide communications to the full extent of your pipeline. Voice frequency repeaters serve as "boosters" along the way, so the voice comes through clear and strong, no matter how great the distance.

everything you need for communication and control



remote control

For remote control of flow and pressure, choose from Automatic Electric's comprehensive selection of relays, stepping switches, and other electrical control components.



To keep your products flowing, Automatic Electric offers complete equipment and years of engineering experience that will help you build or expand your facilities for communication and electrical control. You can depend on Automatic Electric products for year 'round, all-weather operation in telephone, telegraph, or telemetering facilities.

You can realize significant economies by installing the proper communication equipment, correctly adapted to your needs and your existing facilities. Whether you are planning new pipelines, or want to make existing lines more efficient, Automatic Electric counsel is yours without obligation. For full details, write: AUTOMATIC ELECTRIC SALES CORPORATION, 1033 West Van Buren Street, Chicago 7, Illinois. In Canada: Automatic Electric (Canada) Ltd., Toronto.

construction materials

At Automatic Electric you establish a source of supply for *all* your communication needs—and this source is backed by *service* that meets your requirements promptly. Poles, pole line hardware, equipment and tools are all available through your nearby Automatic Electric representative.

COMMUNICATION and SIGNALING
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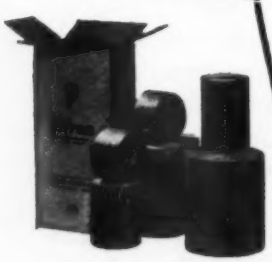
Reinforce Your Pipe Coatings with Vitron

UNDERGROUND PIPE WRAP

Like steel in concrete, glass fiber strands, combined with a closely interlaced web of glass filaments, give excellent reinforcement to coatings on underground pipe lines to help combat electrolytic corrosion.

- ***Parallel Reinforcing Strands*** in VITRON Underground Pipe Wrap provide tensile uniformity from the first foot to the last inch of length, through roll after roll, for ease and speed in wrapping.
- ***High Temperature Resistant*** VITRON Glass Fibers easily withstand coating application temperatures.
- ***Acid Resistant Glass Formula*** for VITRON Underground Pipe Wrap will resist all soil acids.
- ***High Strength*** inherent in glass fibers is effectively utilized when imbedded in coatings. VITRON-reinforced coatings have greater resistance to damage from impact and soil stresses.
- ***Uniform Porosity*** helps the coating bleed through uniformly for a good, continuous film—means fewer "holidays".
- ***Inorganic*** VITRON Underground Pipe Wrap is as permanent as glass itself. It will not rot, or weaken under fungus or bacterial attack.



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used increasingly for its development.

The commercial bankers in large oil centers have been very important factors in bringing about an understanding of the desirability of this type of business and, in this respect, have rendered a very great service to the petroleum industry. The subject: "Oil, Gas, and the Banker," is very appropriate, because the banker has played an important part, and has served an essential role, in the development of the industry. In the beginning it required initiative, sound judgment, intelligence, and great courage, and it is most fortunate for our country that banking and financial interests were able to respond to such requirements.

Today the men directing the affairs of many of the great oil and gas companies have become associated with banking institutions, and now we are very fortunate in having practical and experienced oil and gas men serving on the boards of directors of the leading banking institutions of this country. This has been a tremendous influence in preserving sound policies in the banking, insurance, and public financing of the oil and gas industry.

Credit for Purpose or Profit

The Korean situation has brought about a great change in our national philosophy, and particularly has it precipitated a drastic revision of the banker's thinking. None of us is so clairvoyant that he can lay down a simple and fast rule for future policy. It has become extremely evident, however, that we must hold in store for our defense program a backlog of credit fully sufficient to meet the exacting requirements of impending developments.

Since June of this year, the wholesale commodity index has persistently increased; and, with higher prices, the growing demand for legitimate credit has automatically and necessarily resulted. To forestall an inflationary trend, accelerated by governmental policy, the banker is called upon—if not forced—to be selective in the extension of credit. More carefully must he weigh the facts in regard to the "purpose," rather than the "profit." Speculative or "get rich quick" ventures should receive no consideration. Already interest rates have slightly increased, and there appears nothing on the horizon to justify a prediction of any changing trend.

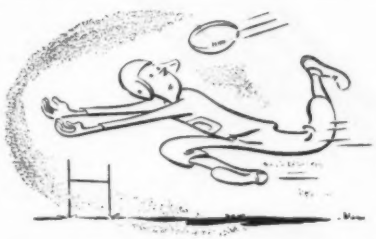
Yet there is no cause for alarm. The natural resources of this country and its financial strength will continue to stand us in good stead. Heretofore we have successfully withstood adversity, and no industry has contributed more on this score than oil. Today the oil industry is truly prepared to render valuable assistance in coping with a national emergency. Proved reserves are increased, pipe-line systems extended, and refining capacity enlarged. Unqualifiedly the petroleum industry deserves the full support of Government and finance in this time of peril; and there is no doubt in the minds of thinking people of its ability to continue to justify this faith.

Water Shipment Less Than Cent

PROGRESS.—Some of the tank ships which transport crude oil and oil products carry as much as 10,000,000 gal. and cost $5,000,000 each. They're so efficient that it actually cost less to ship a gallon of oil from a Texas port to New York City than it does to mail a penny postal card.

Natural Gas for Seat Covers

PROGRESS.—A new all-nylon slip cover for automobile seats that can be removed in a few seconds, washed and replaced without line drying or ironing is one of the latest petroleum-derived products to come on the market. The slip cover is removed by releasing two concealed hooks. After washing and rinsing it may be slipped back on the seat still wet, and will dry within 20 to 30 minutes. Natural gas enters into the manufacture of one of the basic ingredients of nylon.



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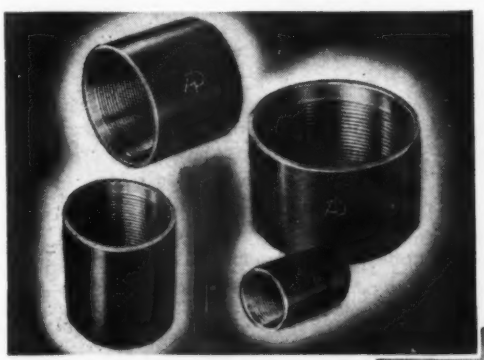
. . . Harrisburg Couplings and Flanges are being delivered to the Oil Country in ever-increasing numbers



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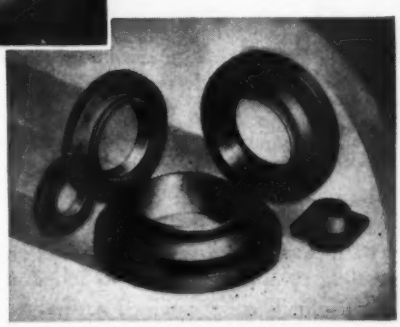

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Interchangeable with counter weights when specified

Sizes
3" & 4"

Pipe length: 7' from center of swing joint to center of end joint; 2' from center of valve to center of swing joint. Drop tube, 2'. Overall length 9', or any length desired.

THIS modernized, long-needed assembly is raised by two compression springs, allowing the loader to return to upright position. The springs are adjustable at top of cam, and are enclosed in hydraulically designed cylinders which control the upward motion of the loading arm. The vertically travel arc is 130 degrees. Smooth, free movement is a feature.

Springs and cylinders are protected with synthetic rubber bellows to prevent water or foreign matter from entering the cylinders. As a safety factor each chain is guarded with an aluminum shield. Compactness is another feature—the Spring-Matic occupies less space on the loading rack.

Note These Other New Features

The ratchet attachment holds the Spring-Matic in fixed position in usage. The chain releases the ratchet.

The cam on which the chain rides is devised to permit spring tension to equalize when the loader is in position.

The inclusion of grounding brushes eliminates sparks and static, ever providing complete contact. No added ground wire is necessary.

Each joint is complemented with a grease retaining ring inserted between five rings of special gasoline packing. The Alemite fittings form a positive seal, simultaneously lubricating the packing.

THE Oilco Spring-Matic assembly illustrated below, serving models 450 and 450-A, may be regulated so that the sliding sleeve can be returned to a vertical or semi-vertical position, thereby permitting loading from either side of a rack.

The loader is equipped with Model 462 Sliding Sleeve Assembly, including a swing joint which allows the dip tube to hang in vertical position when not employed.

The swing joint, at the end of the sliding sleeve, has a handle which permits smooth, easy movement of the sleeve.

Nos. 450 and 450-A

Model 450 omits the valve control lever

Sizes
3" & 4"

Extended Length
10' 4"

Closed
6' 4"

The sliding sleeve encourages maximum flow and is fitted with a newly designed packing gland, fortified with a retaining grease ring and five rings of special gasoline packing, lubricated thru an Alemite fitting.

When in use these units are held in fixed position by the ratchet attachment, but return to an upright position when the operator releases the ratchet with the control chain.

Additional details in the New Oilco Catalog, No. 600. Write for your copy today.

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New developments in

COATINGS AND CATHODIC PROTECTION

by Carlton L. Goodwin

Advances made in corrosion mitigation during the past few years are paying large dividends in lower maintenance expense, longer pipe life, and in continuity of operation. This article reviews some of the more important developments.

CORROSION prevention has become an important part in lowering pipe-line maintenance expense and in improving continuity of operation. Those keeping up with improvements in corrosion control may take advantage of improvements to reduce further their corrosion losses.

Past developments reported before the American Petroleum Institute, substantiated by experience, can be condensed into a few basic statements:

1. Coating and cathodic protection extend the life of pipe subject to external corrosion.

2. Coating alone has a limited effective life—this limit depending on conditions.

3. Cathodic protection has been effective on bare pipe, but the cost of maintaining protection over a long period of time may be excessive.

4. Effective coatings supplemented with cathodic protection have been most successful in arresting and in preventing corrosion losses, with low operating cost for cathodic-protection current.

New developments in coatings.—The trend in oil pipe lines is toward those materials which have and which retain good electrical resistance underground and the lowest solubility in crude oil or crude-oil products.

These limitations presently confine good coatings to hot-applied coal-tar enamels. Field-test data taken on portions of a recently completed 18-in. crude-oil pipe line coated by a traveling-type machine, which line was coated with 180° coal-tar enamel to an average thickness of 3/32 in. and reinforced with a 0.015-in. glass mat and wrapped with 15-lb. coal-tar-impregnated asbestos felt, showed coating resistance between 1 to 30 megohms per square foot. This test was made according to a recognized method of impressing current on the pipe, and of noting the increase in pipe-to-soil potentials with reference to copper-copper sulfate electrodes at the extremities and at intervals along the coated section under test.

Backfill around the pipe was well settled after several heavy rains. With a holiday detector immediately behind the coating machine, the coating was inspected 100 per cent; and holidays were patched before the pipe had been cradled directly into a well-padded ditch. The pipe was padded further, before backfilling, if rocky terrain had to be traversed.

Multilayer glass-mat-reinforced coal-tar coating—supplemented with 18-in.-width abrasion pads on 5-ft. centers made of 5 to 10-layer glass mat saturated with coal tar—has proved to be very satisfactory for rocky stream and river crossings as well as for pulling through long highway and railroad casings. Three layers have been applied successfully with traveling-type coating machines.

Tests, after sections of this type of coated 18-in. pipe had been pulled through a rough ditch, indicate overall coating resistance in excess of 1 megohm per square foot. This means that, in most of these cases, less than 2 ma. of current per 1,000 ft. will be required to put this pipe under 100 per cent protection.

Other products under test during the past few years have disclosed two new ones having possibilities as follows:

1. A product composed principally of reclaimed synthetic rubber has remained effective as an electrical insulator for more than 3 years buried in a highly corrosive sour crude-oil-soaked soil. In the present commercially available form as a cold-applied mastic, it is very convenient to apply to valves, flanges, buried manifolds, and short sections of pipe.

Development into a form which contains reinforcing material, such as glass matting, and which can be applied to pipe lines with a traveling machine over the ditch and immediately lowered into the ditch, should result in lower costs of application and in a long life for the coating.

2. An enamel produced by reacting asphalt and resinous materials has been effective for more than 2 years under the same conditions, whereas normal asphalt enamels failed within 3 months.

Methods and equipment have been developed for applying concrete over coated pipe. One process uses an extrusion principle; the other is similar to gunite application, but it is applied mechanically instead of by air. This concrete-coating system should have possibilities for weighting down larger-diameter pipe in streams, or may be advantageous in protecting against mechanical damage of coating underneath.

Concrete alone as a coating material has proved ineffective and uneconomical in locations most favorable for concrete stability, i.e., in sand and sandy soil near the Great Lakes.

Wrapping materials, which serve as reinforcing or as a soil shield, have seen some improvements; and others, in the experimental stage, appear to offer promising possibilities.

Glass-fiber matting serves only as a reinforcing material for impeding cold flow in bitumen coating, and it does not have the essential properties as a shield against soil stress. Glass-fiber matting impregnated with bitumen (asphalt) is being marketed as a soil-stress shield, but its effectiveness can be determined only after it has been in service.

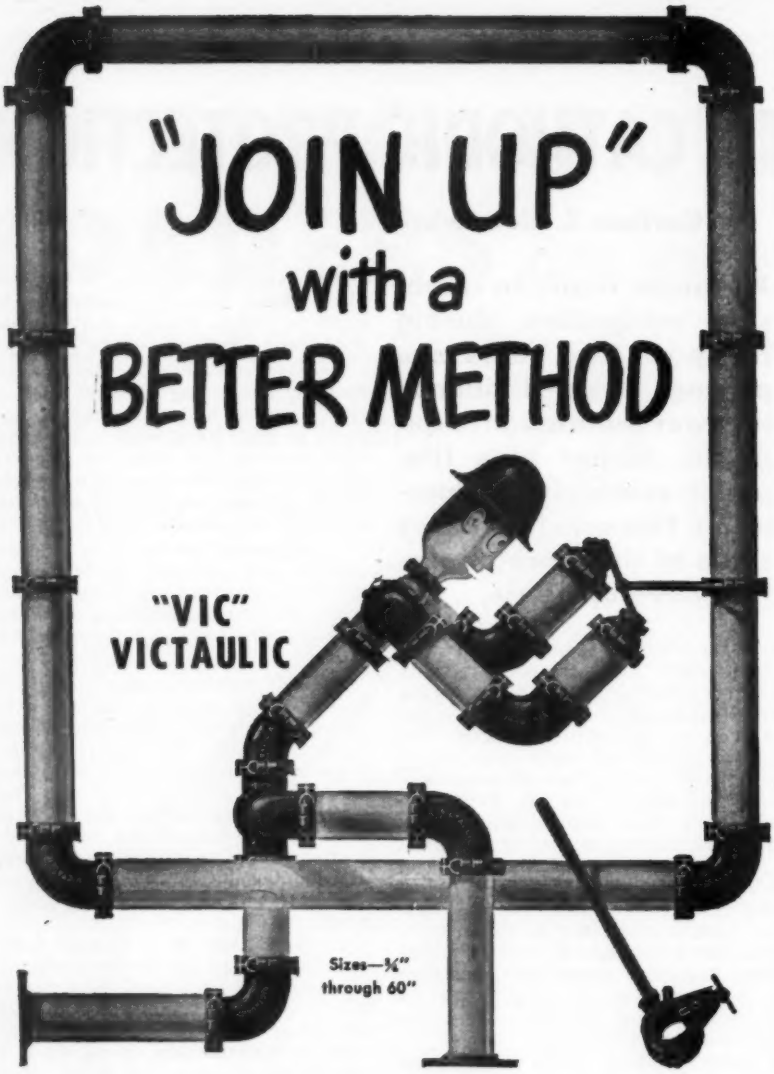
Asbestos felt is presently recognized as a preferable soil-stress shield. A glass-fiber mat, impregnated with a synthetic rubber of known underground stability, is in the development stage; it offers promise as a soil-stress shield.

There is a definite need for a lighter soil-stress shield wrapper for use on traveling-type coating machines, where glass-mat reinforcing and an outside shield are applied. Wrapper of lighter weight would allow greater lengths in rolls—thus giving more distance of travel per roll and resulting in better economy of application; it

THE AUTHOR

Carlton L. Goodwin is corrosion engineer for Portland Pipe Line Corp., Portland, Me. He received his B.S. in chemical engineering from University of Maine in 1932, and joined Portland Pipe Line in 1941. He has served in several capacities in operations and engineering.

Paper presented at A.P.I. thirtieth annual meeting, Los Angeles, November 9-17.



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would also reduce the amount of weight to be transported or handled. For example:

Each time that a traveling-type coating machine, which applies hot enamel reinforced with a glass mat, is stopped for a few minutes, 2 to 5 ft. of hot-applied coating are without glass-mat reinforcement, and the wrapper does not bond to the coating. In the case of 400-ft. rolls of 18-in. felt and glass mat used on 18-in. pipe, this amounts to 2 to 5 per cent of the length of the pipe lacking these essential materials.

Use of the Pearson holiday detector to locate coating defects after pipe burial has contributed much toward coating improvement. Detection of defects and their excavation have revealed the causes in most cases, and have made possible means for the elimination of their recurrence.

Cathodic - protection developments. Direct-current supply at low voltages is required for the application of cathodic protection. Various methods have been tried during the past for providing current; these include galvanic anodes, motor or engine-driven generators, wind-driven generators, thermal generators, and rectifiers.

The principal sources of protective current now in use originate from galvanic anodes and rectifiers. Dry-type rectifiers have proved most successful and dependable. The copper-oxide elements were the most popular in use before the exhaustion of the copper supply suitable for their manufacture.

Rectifiers require proper cooling, protection from moisture or water, and exclusion of insects. Housings for outside mounting units must be carefully designed in order to fill the foregoing requirements.

Improvements in rectifiers. — Improvements have been made by immersing the entire rectifier unit in oil; this results in better cooling and in more effective exclusion of moisture and insects. Oil-immersed units also have the advantage of greater safety in locations where fire hazards exist, and they are little affected by a corrosive atmosphere. Larger rectifier units are available for three-phase circuit operation; these give higher efficiencies.

Ground beds for rectifiers. — The ground bed, or the anodes and connecting cables, required for a rectifier installation often cost more than the rectifier unit; the subsequent cost of maintaining a ground bed depends upon the type of anodes installed.

Anodes of iron or iron alloys are consumed at a theoretical rate of approximately 20 lb. per ampere per year. Carbon or graphite anodes for an equivalent current time have a theoretical loss rate of only 2 lb.

The increasing price of iron has diminished the use of scrap-iron materials for ground beds; hence carbon

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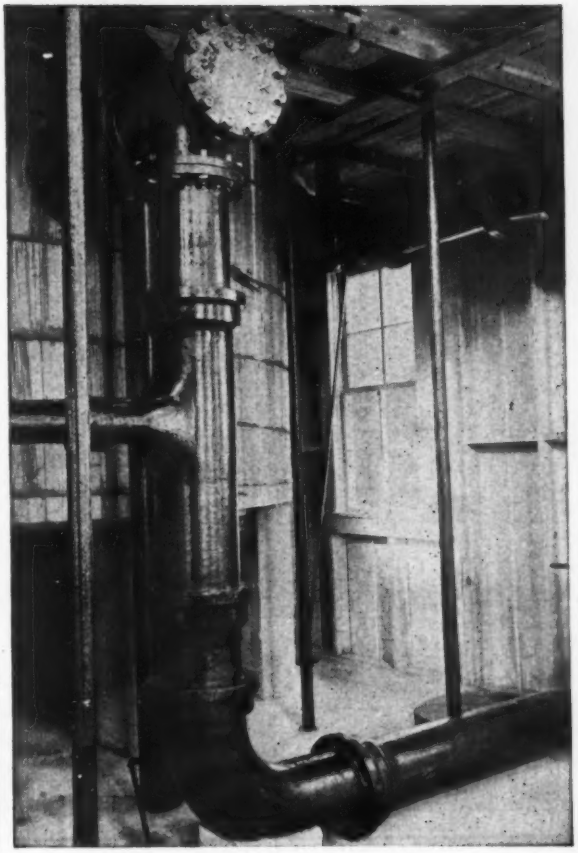

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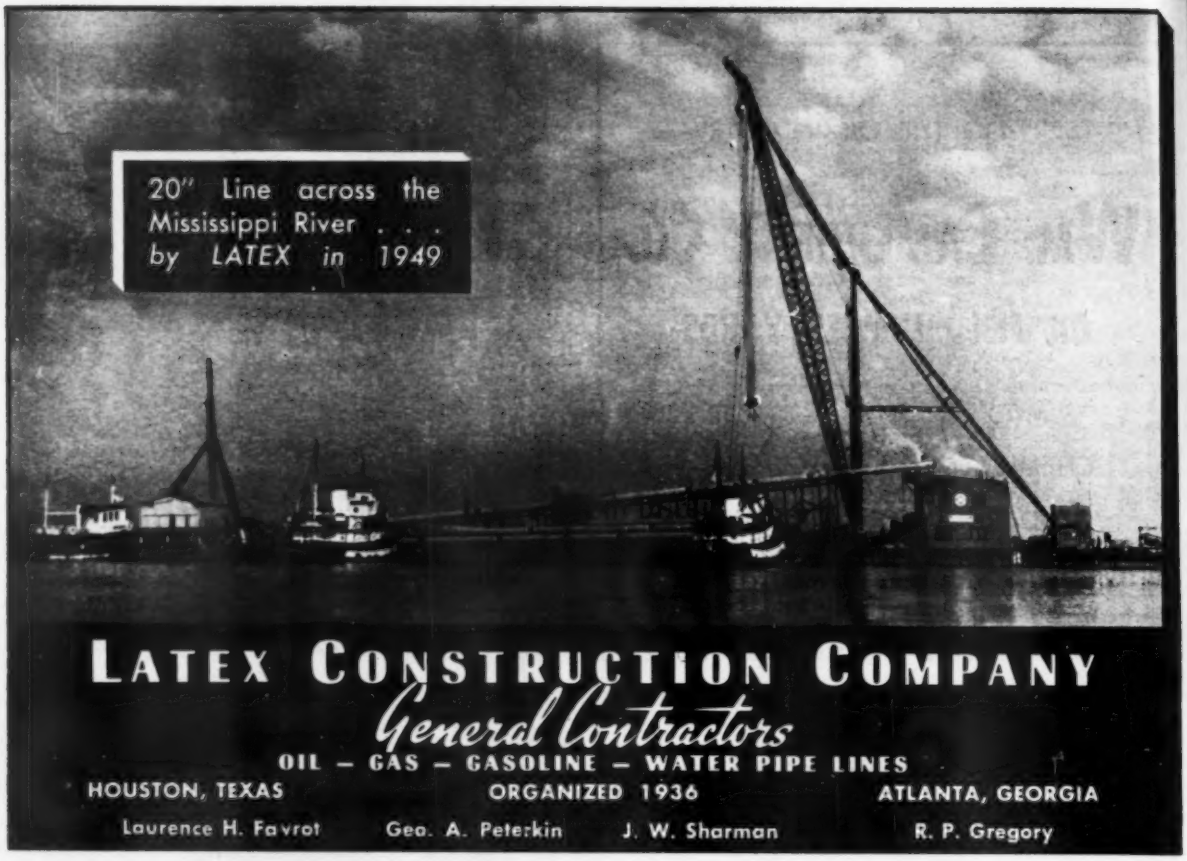

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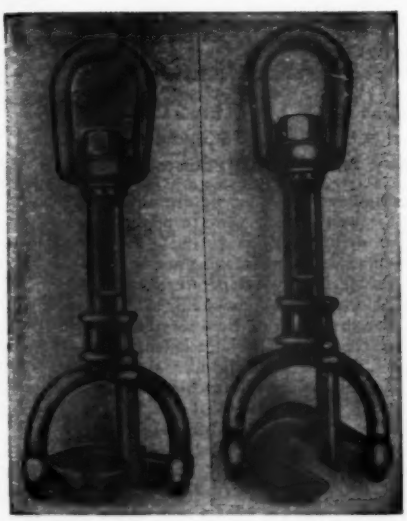

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or graphite anodes are used more extensively.

Carbon anodes are subject to rapid disintegration under some conditions—especially when, during operation, chlorine is evolved at the anode surface. This disintegration results from segregation of the carbon particles in the anode; it does not result from decomposition of the carbon. Graphite anodes are more stable in such environments.

With respect to rectifier ground beds, it is important that individual carbon or graphite anodes be located properly in relation to one another, and to the pipe line, if efficient and economical operation is to be obtained. The type of soil, as well as uniform adequate moisture content, is also important.

Crushed coke (coal coke), known as "coke breeze," can be used to advantage with carbon or graphite anodes, i.e., as a backfill in the space between the anode and the soil surface. Such an installation helps to lower groundbed resistance, and it extends the life of the anode. Bored holes for this type of installation should not exceed 24 in. in diameter, and the coke breeze should be tamped well to give the best results.

Petroleum coke is not suitable for use around anodes unless it has been heated to a temperature above 1,800° to 2,000° F. in an oxygen-free retort.

Development work is under way to provide a ceramic container for placement in bored anode holes; this container will allow anode replacement or addition of coke breeze without excavation, thus minimizing maintenance cost for ground beds designed for 20-year operation or longer.

Improvement in galvanic anode installations.—Galvanic anodes are limited to those metals which cause current flow when they are connected to the pipe, and when this current flow consumes the anode. The practical materials available for anodes are zinc, aluminum, and magnesium.

Zinc does not cause as much current flow as the other two metals under equivalent conditions; however, it has the advantage of high efficiency in current delivered per unit of metal consumed, and this metal suffers little or no loss in the soil when disconnected from the steel pipe.

Aluminum anodes require special backfill, and some of the chemicals necessary for the maintenance of operation require caution in handling and installing. The present trend does not indicate extensive use of this metal for galvanic anodes.

Magnesium metal—particularly one type of magnesium alloy—is most generally in use for galvanic anodes for the protection of underground pipe. Magnesium continues to be consumed in most soils whether connected or disconnected to buried steel pipe; hence it is advantageous to operate such anodes at a relatively high-

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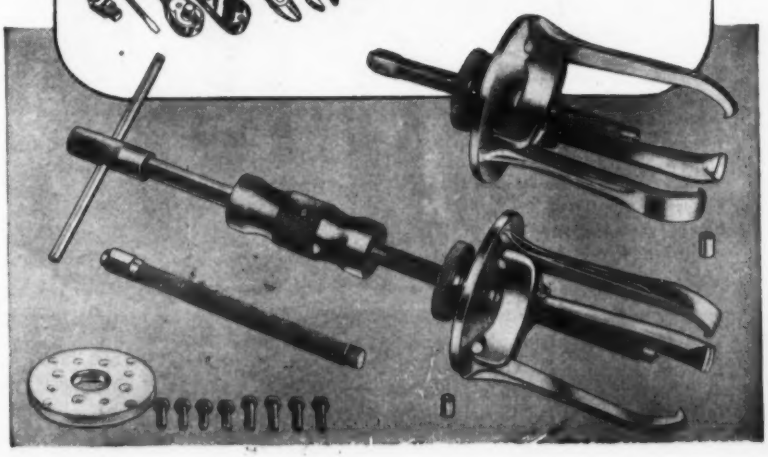

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Ground beds for lightning protection.—Attention is invited to the long-standing practice of driving copper-clad rods which serve to ground electrical equipment so as to take care of surge or fault current.

These large areas of exposed copper are connected, through motor frames and other equipment, in such a way as to expose all buried conduit, cable sheaths, and underground pipe in the vicinity so that those will become anode surfaces.

This practice has contributed in no small way to pipe failures around pump stations and other structures. This source of destruction can be eliminated by substituting zinc ground rods for copper rods, thus providing beds which will decrease in resistance with time and which will provide some degree of cathodic protection to conduits, sheaths, and pipe. Such ground beds should be checked periodically to determine the need for replacement because of their being consumed by supplying cathodic-protection current.

Further advantages are gained when cathodic-protection current is supplied for station piping from rectifiers, or from other sources, because the zinc ground bed will not permit current flow from the soil to the zinc surface until all iron surfaces are well above the normal protective voltage level.

Other corrosion-control measures.—It is widely recognized that the installation of insulating gasket assemblies in flanges, at certain locations in pipe lines, will assist in the control of corrosion caused by stray electrical currents. However, heavy electrical surges—which result from the effects of lightning or other high-voltage sources—in some instances have punctured parts of the insulating assembly.

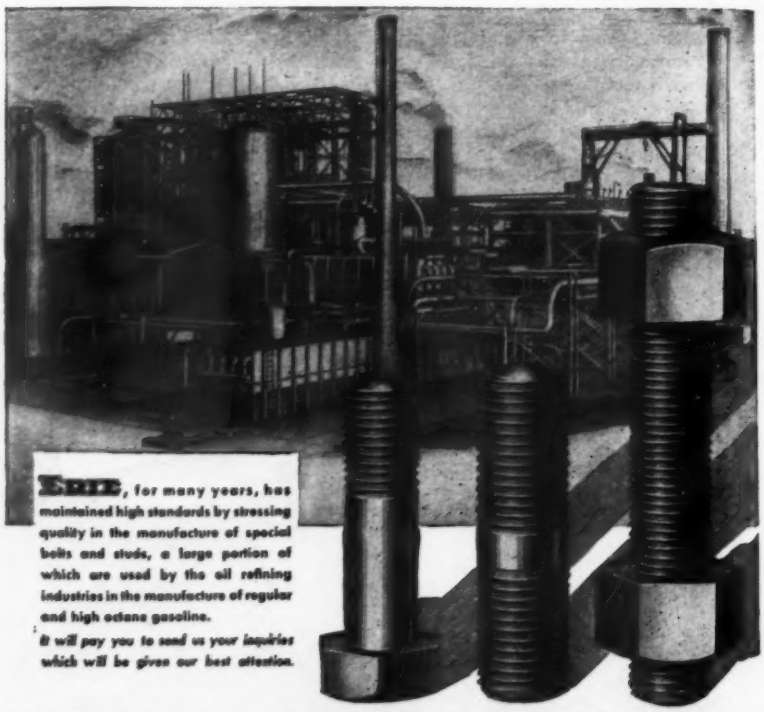
Very recently an insulated washer has been developed for installation in place of the regular insulating washers on one of the flange bolts. This washer, in its thin insulating material, has perforations which act as a surge gap.

This new assembly takes care of high-voltage surges, and prevents damage to the more inaccessible parts of the gasket assembly. Other more intricately designed lightning arresters are being used to accomplish the same results.

The advances made in corrosion mitigation during the past few years undoubtedly are paying large dividends in lower maintenance expense, longer pipe-line life, and continuity of operation. Further research, continued development of new ideas and materials, and mutual exchange of the results of these efforts throughout industry will result in further conservation of valuable metals, in lower transportation costs, and in a reduction in losses of crude oil and products. In the final analysis, all these mean a higher standard of living for all.

Acknowledgment

Considerable credit is due Senior Corrosion Engineer O. C. Mudd, of Shell Pipe Line Corp., Houston, for much of the information contained in this paper.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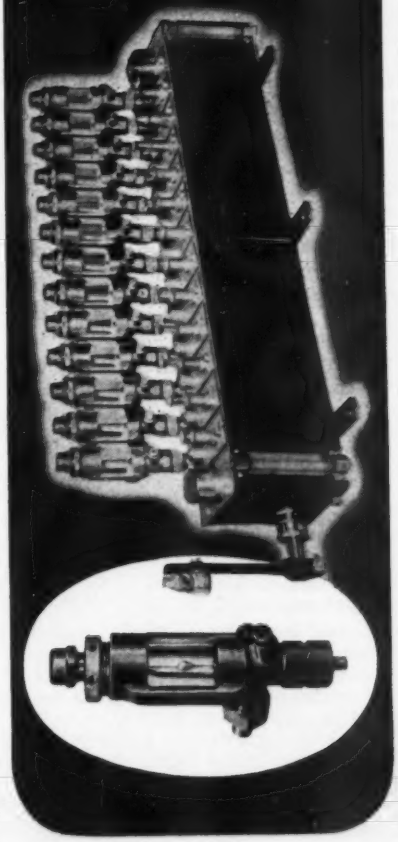

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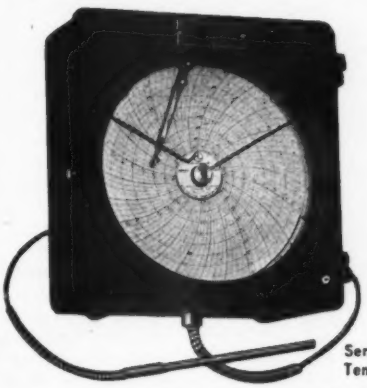

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QUESTIONS on TECHNOLOGY

by W. L. Nelson
Consulting Engineer

Saybolt Distillation of Crude Oil

What is meant by a Saybolt distillation on crude oil?—J. A. M.

There are three general types of crude oil batch distillations:

1. **Ten per cent or nonfractionating.**—The old Saybolt distillation is one example and A.S.T.M. Designation D 158-42 "Distillation of Gas Oil and Similar Distillate Fuel Oils" is sometimes used for crude oil. The customary A.S.T.M. distillation for gasoline and kerosine is the best-known type of nonfractionating or 10 per cent distillation but it is seldom used for crude oils.

2. **Semifractionating.**—In these distillations a mild degree of fractionation is attained by the use of a section of packed column between the flask and the inlet to the condenser. The best known example is the 300-ml. Hempel distillation conducted by the U. S. Bureau of Mines. It is somewhat similar to the 300-ml. crude-oil distillation designated by the A.S.T.M. as D 285-41, except that the Bureau of Mines Hempel is conducted at 40-mm. pressure after the fractions that distill at atmospheric pressure have been collected.

3. **Fractionating.**—These are commonly called true-boiling-point (T.B.P.) distillations. Various changes (2,000 ml. to 5 gal.) are employed and a sufficiently long fractionating column is provided to obtain a distillation curve whose shape and position is not materially altered by a greater degree of fractionation.

The name "Saybolt distillation" originated so many years ago that details of the operation are not now readily available. However, from discussions with older chemists, it is learned that it consists of a 200-ml. distillation conducted at atmospheric pressure in a so-called Saybolt flask (see A.S.T.M. Designation D 158-41 for a description). The distillation was conducted at such a rate as to be completed in about 20-40 minutes depending upon the amount of distillable material in the oil. No deliberate refluxing or attempts to accomplish fractionation were employed and the results were recorded as percentage collected in the receiver versus vapor temperature.

W. A. C. Schlueter, in his 1920 edition of "General Testing Methods and Tables for Mineral Oils" (Refinery Supply Co. of Tulsa) which later became the well-known "New and Revised Tag Manual for Inspectors of Petroleum," indicates that the name Saybolt distillation was used in speaking of a 200-ml. gasoline and naphtha distillation, and that it originated in the Saybolt department of Standard Oil Co.

The approximate relationship between the three general types of distillation is indicated in Fig. 1 which shows approximate curves for a light and a heavy crude oil and for a naphtha.

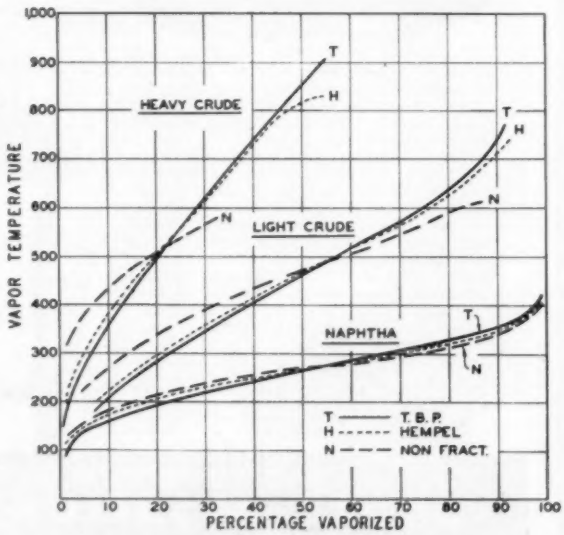


Fig. 1—Approximate relationships between different types of distillation curves.

Evaluating Jet Fuels

How can you determine the amount of jet fuel that is contained in our crude oil? What about the freezing point of minus 76 F.?—R. C. P.

So little is known of the freezing points of gasolines or kerosines that about the only dependable suggestion is that the freezing point should be determined experimentally. There are, however, certain generalities that will be stated later.

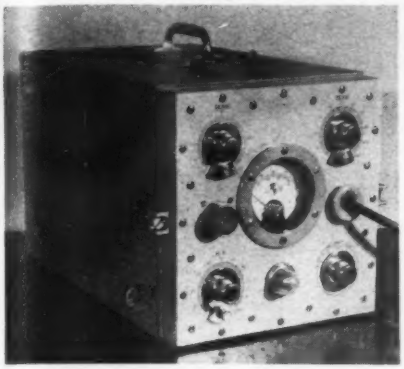
Current jet-fuel specifications (Military Specifications, MIL-F-5624, Fuel; Aircraft Turbine and Jet Engine JP-3, January 26, 1950) in an abbreviated form are:

Freezing point	minus 76° F. max.
Corrosion	slight discoloration of copper strip
Residue	10 mg. per 100 ml.—by air jet evaporation
Aromatics	25 per cent max.
Sulfur	0.5 per cent max.
Gravity	45°-63° A.P.I.
Reid v. p.	5-7 psia. at 100° F.
Gum (accelerated)	20 mg. per 100 ml.
Inhibitor	1 lb. per 5,000 gal.
Bromine number	30 max.
Heating value	18,400 net, min.
Distillation:	
90 per cent point	400° F. min.
End point	600° F. max.
Residue	1½ per cent max.
Loss	1½ per cent max.

The limiting specifications are usually the freezing point and the aromatic content. Means of judging the freezing point are not well developed but in general the paraffinic or high-characterization-factor materials have high freezing points. If the characterization factors of both the gasoline-kerosine and the lubricating-oil fractions are below 12.0, the freezing point will probably be satisfactory. The two characterization factors should not be averaged but a study of a few crude oils indicates that a material of high gasoline-kerosine factor (such as 12.2) can be satisfactory if the lube fractions have a very low factor (under 11.7). Characterization factor has been discussed in several recent issues of Questions on Technology, March 9, 1950, page 94; March 23, 1950, page 348; April 27, 1950, page 200; and May 4, 1950, page 147.

Gasoline-kerosine fractions seldom contain as much as 25 per cent of aromatic hydrocarbons. Most generally, the aromatics are high if the characterization factor of the gasoline-kerosine fraction is lower than about 11.6. However, there are examples of even naphthenic crude oils such as Smackover (Arkansas), and Sunset (California) which have factors of 11.45 and 11.15 which do not contain 25 per cent of aromatics.

At the present state of knowledge, it seems that satisfactory jet fuel can be produced from intermediate-base crude oils having gasoline-kerosine characterization factors of 11.6-12, if the characterization factor of the lube fractions is not higher than 12. There are, however, very many exceptions and hence at the present time laboratory tests must be recommended.



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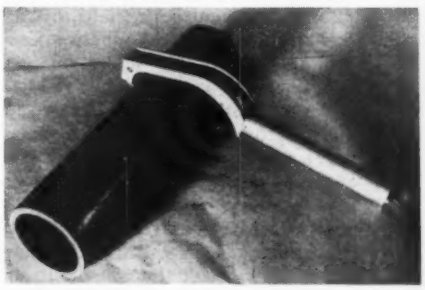

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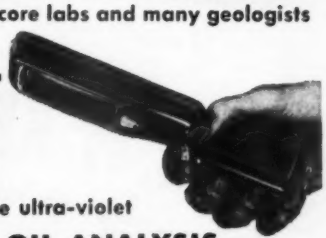

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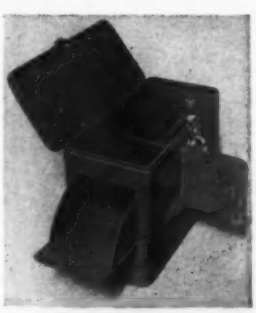

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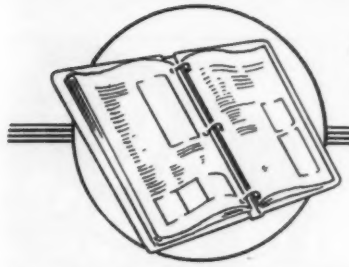


THE REFINER'S *notebook*

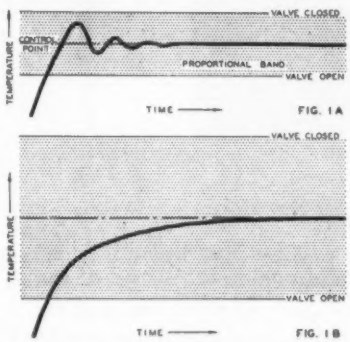
Controller Action on Startup*

IN recent years thinking has been principally directed toward a reduction of the magnitude and duration of the offset resulting from load changes in the process. This is particularly true in the oil and chemical industries where processes require a wide throttling range (low sensitivity). So many of the applications in these industries are of this character that automatic reset is almost a standard feature in the controllers to return the controlled variable to the desired value following load changes. In recent years, on temperature application in particular, derivative function has been added to controllers with automatic reset which further reduces the magnitude of the deviation and bring the temperature back to the control point more quickly.

Startup problem.—There is another characteristic of automatic control systems which often is of greater importance than the magnitude and duration of the deviation from the control point after a load change. This is the overpeaking which occurs when a control system is started up or when the control variable deviates beyond the edge of the control band. While we normally think of these startup characteristic as being important only on batch operations, it can be equally important on continuous and semicontinuous operations.

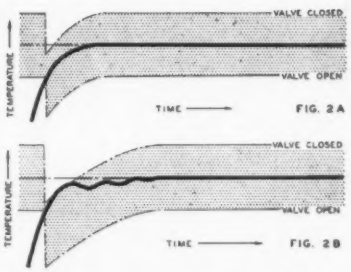
First, let us briefly review the startup characteristics of the conventional control systems. Assume that all of the controllers are applied to a single process which involves the heating of a material to a predetermined temperature and proportional to the valve opening. Since we must select a given load for comparison purposes, let us select the 50 per cent load condition which requires that the valve remain half open to maintain the temperature at the control point.

Proportional controller.—When a proportional controller is adjusted to a reasonably narrow proportional band to minimize the effect of load changes, the temperature record on startup might be very similar to that shown in Fig. 1A.



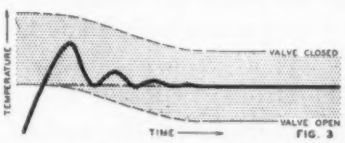
Note that the shaded area extends from the temperature corresponding to the open valve position to the closed valve position. In this, and in subsequent figures, the position of the temperature in the band at any time therefore indicates the opening of the valve. Now, in Fig. 1A it will be noted that overpeaking occurs and if this must be avoided, the proportional band can be widened as illustrated in Fig. 1B. While this eliminates the overpeaking, such adjustment of the controller is often unsatisfactory because it takes the temperature too long to come in to the control point, and also because the deviation following subsequent load changes will be excessive.

Proportional plus derivative controller.—If the derivative is added to the proportional response in the controller, the startup characteristics can be materially improved. The derivative function has a stabilizing effect and with a given band width, it reduces the tendency of the controller to oscillate. For example, in Fig. 2A the band width remains identical with that in Fig. 1A but sufficient derivative action has been added to prevent overpeaking. If we continue to use the proportional band as a means of illustrating the valve position, it shifts downward at the time the temperature reaches the



lower edge of the band. Fig. 2B illustrates the characteristic approach curve which may be obtained when the derivative function is excessive. When a curve similar to that illustrated in Fig. 2B is obtained, the proportional band may sometimes be narrowed so that the temperature arrives at the control point most quickly than would be the case if the proportional response were left in the adjustment corresponding to that shown in Fig. 2A.

Proportional plus reset controller.—When automatic reset is added to the proportional response in the controller and the controller is in a satisfactory adjustment, the startup characteristics may be very similar to that illustrated in Fig. 3.



Note that the proportional band is entirely above the control point during the startup period and that it subsequently shifts downward after the temperature passes this control point. Due to the fact that there is no action until the control point is reached, the overpeaking is considerably worse than it was before the automatic reset feature was added. If the instrument sensitivity were lowered or its proportional band widened as was done in Fig. 1B, the overpeaking will become worse rather than better. This is due to the fact that the band becomes wider on the upper side of the control point, and therefore the rising temperature will make a greater excursion into this band before the shift of the band returns the variable to the control point.

*Portion of paper "Tri-Act Control—A New Concept," by R. E. Clarridge, Taylor Instrument Co., presented at fifth annual instrument symposium, Texas A. & M. College.

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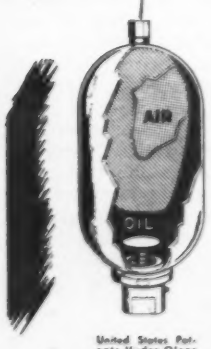

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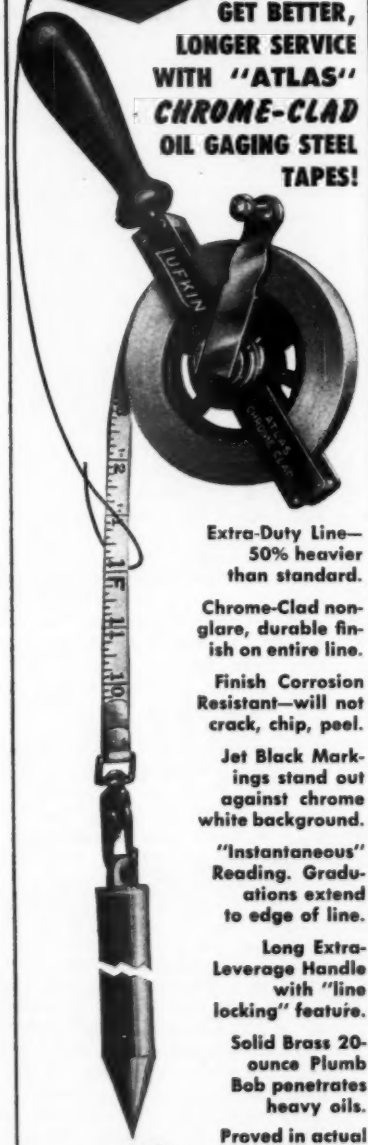

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Reservoir Water

THE water that is produced with oil in some reservoirs is generally differentiated as interstitial water or encroaching water. The first usually means that which exists in the same pores which hold the oil. Encroaching water usually means that which existed in a separate oil-free portion of the reservoir rock and has been produced by virtue of its movement into the oil-saturated portion. Some engineers use the terms interstitial water and connate water interchangeably and others use the term connate to mean any water that originally existed in the earth in order to differentiate from injected water. The differentiation between interstitial water and encroachment water can never be clear cut because there is never any exact single plane of demarcation separating oil-filled and water-filled portions of a reservoir.

Interstitial water is generally thought to be that which satisfies the capillary "irreducible minimum" of the reservoir rock. Waters so held could not be produced unless the capillary forces could be overcome. Their production should sometimes be possible because the "irreducible minimum" is not really a constant. The capillary pressure curve is actually sloping to a slight degree with respect to water saturation. Therefore, if it is possible under production conditions to apply gradients such that the capillary pressure is moved to a higher value, a slight lowering of interstitial water would result and the difference would be produced. This is illustrated in Fig. 1. This might account for the small water cuts

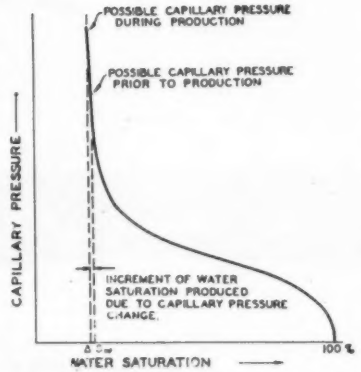

POSSIBLE CAPILLARY PRESSURE DURING PRODUCTION
POSSIBLE CAPILLARY PRESSURE PRIOR TO PRODUCTION
CAPILLARY PRESSURE
INCREMENT OF WATER SATURATION PRODUCED DUE TO CAPILLARY PRESSURE CHANGE.
100 %
WATER SATURATION

Fig. 1—Showing possible water production due to capillary pressure change.

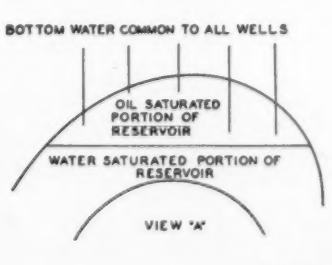
which are sometimes observed in producing wells. Water production from this source would decrease in amount as production proceeds.

Encroaching water is sometimes differentiated as edge or bottom water. This differentiation is meaningless from the standpoint of reservoir mechanics but it does have significance in well-completion problems. Bottom water is represented by view A in Fig. 2, and it would be common to all wells drilled. Edge water is illustrated by view B and would be a completion problem only in a portion of the wells.

Inasmuch as reservoirs are seldom uniform throughout in rock characteristics, it is frequently found that water may appear at intervals in a well above a known or recognizable water table. This may be explained by differences in capillary character of the reservoir rock with depth. Fig. 3 represents a well drilled through a reservoir sufficiently heterogeneous that water exists in different concentrations at different levels, at perhaps one of which the penetration may be through a transition zone so that production of water occurs, although a water table cannot be distinguished.

The water reservoir which exists with an oil reservoir and supplies the water for encroachment may be of any size. It has been suggested that such reservoirs of water be called open or closed. Just as an oil reservoir may be stratigraphically or otherwise sealed, so may a combination oil and water reservoir be sealed. There would thus be a limit to the water supply available for encroachment purposes. The water from such a reservoir would encroach on the oil-bearing portion by virtue of the expansion of the water as the reservoir pressure was released. The relative sizes of the oil-bearing portion of the reservoir and the water-bearing portion of the reservoir would hence be important, at least up to that size of water reservoir which could supply all the necessary water to completely displace the oil before depletion. Beyond that size, the water reservoir might well be considered as an open type.

Open-type water reservoirs would be those which were unsealed so that a continuing supply of water was available. Such a case would be illustrated where the reservoir bed continues unbroken and permeable for some distance and eventually outcrops. The supply of water available for encroachment in such an instance is not limited by the expansion of the water but by the pressure gradient available.



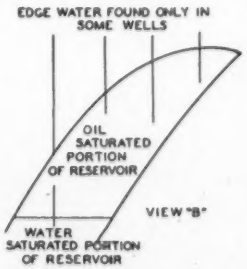
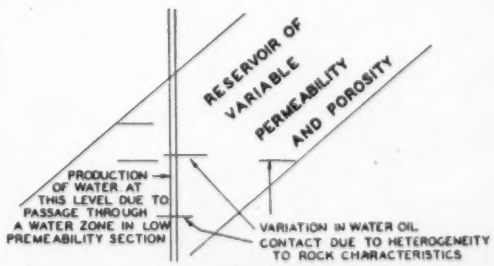


Fig. 2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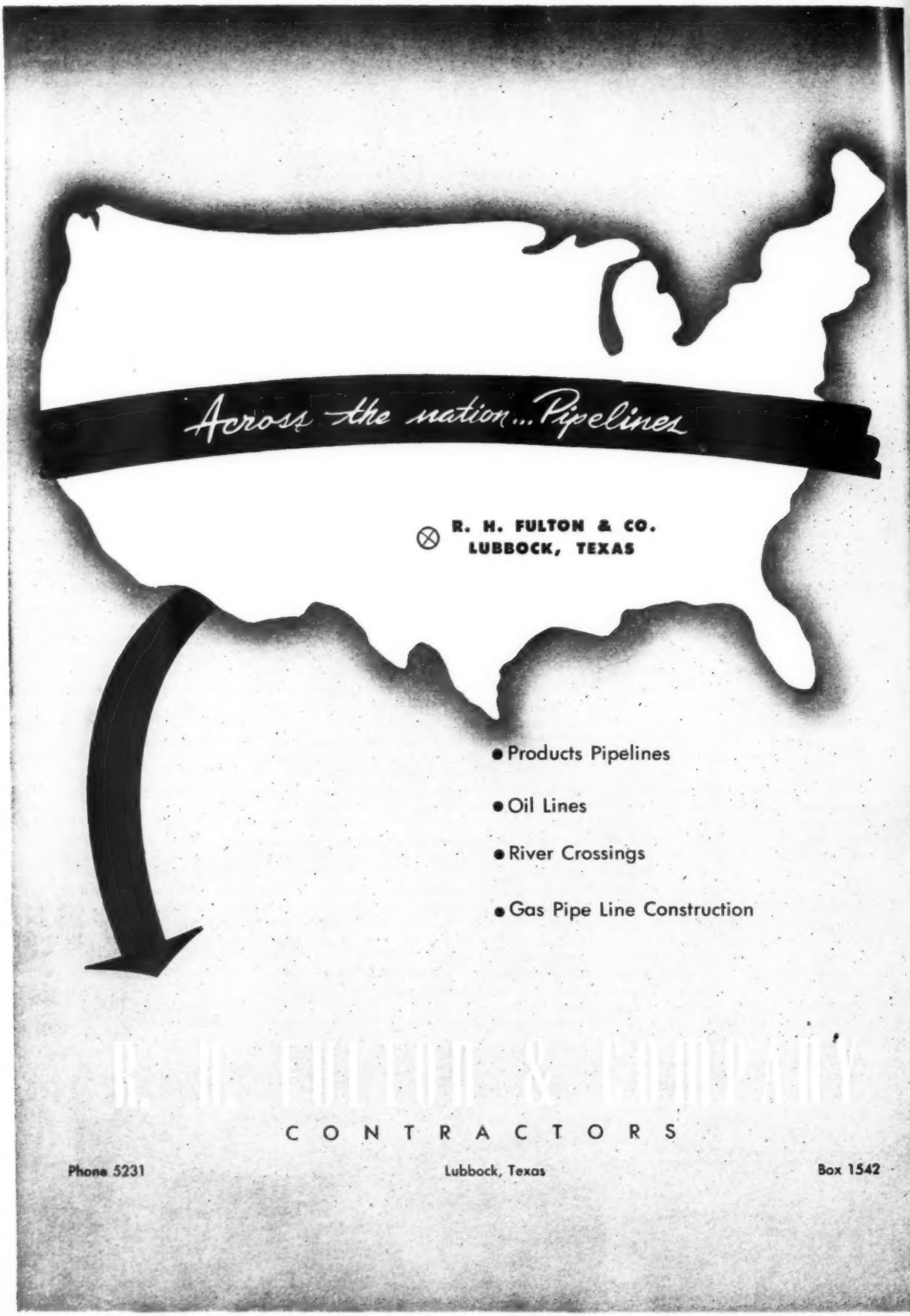
PRODUCTION OF WATER AT THIS LEVEL DUE TO PASSAGE THROUGH A WATER ZONE IN LOW PREMEABILITY SECTION
VARIATION IN WATER OIL CONTACT DUE TO HETEROGENEITY TO ROCK CHARACTERISTICS

Fig. 3

Series by Dr. John C. Calhoun, Jr., Chairman, Petroleum Engineering School, Penn State College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PIPE LINES

Oil Flow Lowered

Pipe-line runs in 1949 dropped 249,000,000 bbl.

WASHINGTON.— Seventy-four pipe-line companies classified as common carriers delivered a total of 2,447,942,894 bbl. of crude and products out of their systems in 1949, it was reported last week by the Interstate Commerce Commission.

The 1949 deliveries, the report showed, were some 249,000,000 bbl. less than those of 1948 and the smallest of any year since 1946.

During the year, it was shown, the 74 companies received 748,617,579 bbl. of crude and 57,174,436 bbl. of products from connecting carriers and originated 1,414,886,575 bbl. of crude and 240,850,328 bbl. of products. The comparable figures for 1948 were 851,446,666 bbl. of crude and 54,283,464 bbl. of products received from other carriers and 1,586,331,016 bbl. of crude and 227,480,846 bbl. of products originated.

Deliveries included 740,202,729 bbl. of crude and 51,925,633 bbl. of products to connecting carriers, and 1,405,325,716 bbl. of crude and 250,488,633 bbl. of products terminated. In 1948, 829,232,167 bbl. of crude and 51,175,291 bbl. of products were delivered to other carriers and 1,589,730,078 bbl. of crude and 227,001,314 bbl. of products terminated.

Trunk-line movement.—Trunk-line movement was given 1,753,996,239 bbl. of crude for a total of 497,178,743,000 miles and 302,588,264 bbl. of products for 82,562,756,000 miles last year, compared with 1,947,066,490 bbl. of crude moved 513,497,782,000 miles and 280,019,453 bbl. of products moved 85,087,129,000 mile in 1948.

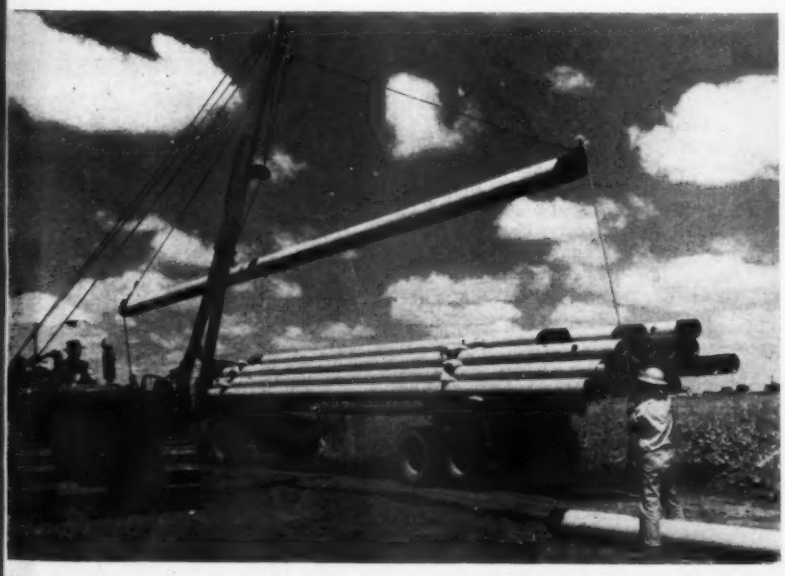
The mileage operated in 1949 included 47,212 miles of gathering and 77,772 miles of trunk lines, and the investment in carrier property was reported at $1,497,578,988; in 1948, there were 47,036 miles of gathering and 77,056 miles of trunk line and the carrier-property investment was $1,381,402,464, the commission reported. Operating revenues were reported as $376,452,116 against $377,034,023 in 1948, and operating expenses were $249,368,200 against $252,970,772.

Virginia Markets Opened

RICHMOND.—Natural gas starts flowing this month through the new $7,100,000 transmission system of Commonwealth Natural Gas Corp. First deliveries are scheduled for Hopewell and Petersburg markets by mid-November, with full activity reached 30 days later.

The 200-mile pipe line extending from Stanardsville to Norfolk, Va., is designed to carry a potential load of 126 million cubic feet daily. The company receives its natural gas from Columbia Gas System, Inc.

Acquisition of Portsmouth Gas Co. is the most recent action in Com-



PAN-AM JOB.—Crew unloads 10-in. line pipe to be used in constructing a new gathering system for Pan-American Pipe Line Co. in Scurry County, Texas. The new line parallels Pan-Am's existing 6-in. line, to pick up oil from the Kelly-Snyder field.

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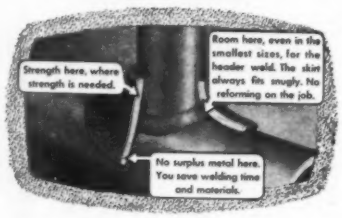
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monwealth's program to absorb local distribution facilities. Negotiations are in progress to take over facilities in other communities.

Northwest Line Planned

WASHINGTON.—Westcoast Transmission Co., Inc., Wilmington, Del., has applied to the Federal Power Commission for authority to construct approximately 615 miles of pipe line in the Pacific Northwest to supply natural-gas markets in Oregon and Washington.

The project, estimated to cost $25,690,000, would have a designed capacity of 221 million cubic feet of natural gas per day in the fifth year of operation. Westcoast proposes to obtain its supply of natural gas from its Canadian associate, Westcoast Transmission Co., Ltd.

The latter company is planning to build a pipe-line system to transport gas from northern areas of Alberta and British Columbia to a point on the international boundary near Sumas, Wash., where it would connect with the proposed system of its United States associate. The Canadian company also plans to build a spur from a point on its main line near Princeton, B.C., to another point of connection with the U. S. company's system on the international boundary west of Osoyoos, B. C.

Westcoast would construct two main lines, one extending south from the Sumas area to Portland, Ore., with short branches to Bellingham, Mount Vernon, Everett, Bellevue, Seattle, Tacoma-Olympia, Centralia-Chehalis, and Kelso-Longview, all in Washington, and St. Helens, Ore. The other main line, extending south from the Osoyoos area, would serve Spokane and the Atomic Energy plant at Hanford, both in Washington.

The main line to the west coast communities would be about 277 miles long, and the line in eastern Washington would have an estimated length of 266 miles. In addition, the company would build about 72 miles of lateral lines, and some 13 measuring and regulating stations.

The Canadian company, in addition to supplying natural gas to its U. S. associate, would serve various markets in Canada, including Vancouver, B. C.

Mississippi Crossing

ST. LOUIS.—Overhead crossing of the Mississippi River near Grand Tower, Ill., is the only construction work not yet under contract for Texas Illinois Natural Gas Pipeline Co.'s artery from Falfurrias, Tex., to Joliet, Ill. Two 30-in. lines will be suspended above the river from steel towers and cables. Total construction cost of the system is estimated at $98,966,700.

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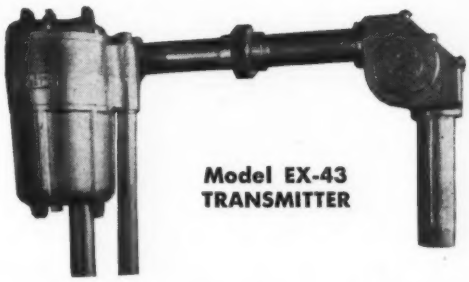

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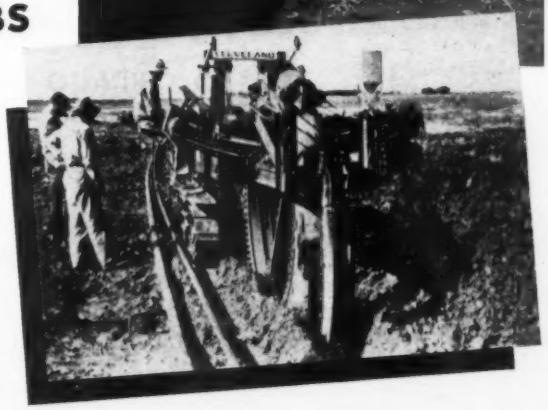

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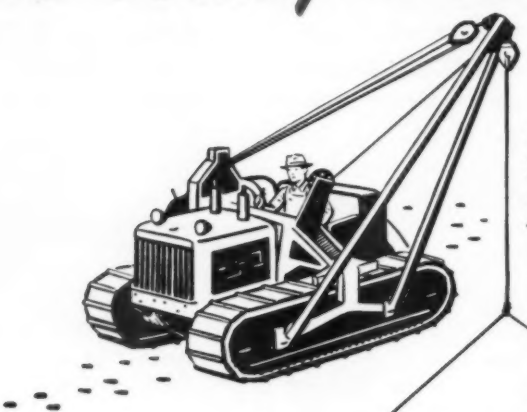

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Pipe-Line Construction

FOLLOWING is a tabulation of pipeline projects which are planned or under construction. Included are crude-oil, products, and natural-gas lines. The list was compiled from surveys made by The Oil and Gas Journal.

Crude-Oil Pipe Lines

Gulf Refining Co., Tulsa Pipe Line Division.—72 miles, 6-in., under way, El Dorado, Kans., to Webb City, Okla.; Pipeline Service Co., contractor. J. W. Welcher, Atlanta, Kans., spreadman.

Lakehead Pipe Line Co., Inc. (American subsidiary of Interprovincial Pipe Line Co., Canada).—321 miles, 18-in., contracted Neche, N. D., to Superior, Wis., to be completed October 1950; Anderson Bros., contractor.

Ohio Oil Co.—54 miles, 20-in., underway in Illinois; Betchel Corp., contractor; S. D. Betchel, Jr., superintendent.

Pan American Pipe Line Co.—80 miles, 10-in., under way, from southern part of Scurry County, Texas, to a connection with Humble pipe line near San Angelo, Tex.; Brown & Root, contractor.

Pelican Oil Co.—60 miles, 6-in., under way, Lake Charles to DeQuincy, La.

Phillips Pipe Line Co.—50 miles, 6-8-in., under way, Phillips tank farm, Sweeny, Tex., to Humble's Webster Station, Galveston County, Texas; O. R. Burden Construction Co., contractor; B. C. Barney Hall, spreadman.

Phillips Pipe Line Co.—25 miles, 8-in., considered, loops between Thrall and Kansas City, Kans.

Platte Pipe Line Co.—1,080 miles, 16-20-in., planned, Worland, Wyo., to Wood River refining area in Illinois.

Portland Pipe Line Co. (Montreal Pipe Line Co., Ltd.).—236 miles, 18-in., contracted, Portland, Me., to Montreal, Que., Canada.

Portland Pipe Line Co. (Montreal Pipe Line Co., Ltd.).—85 miles, 18-in., under way, Portland, Me., to Gorham, N. H.; Oklahoma Contracting Co., contractor of Section 1; H. A. Waylie, Westbrook, Me., superintendent.

Portland Pipe Line Co. (Montreal Pipe (Canada).—321 miles, 18-in., contracted, Gorham, N. H., to international boundary near N. Troy, Vt.; Associated Pipeline Contractors, Inc., contractor of Section 2. Lacy Walker, Barton, Vt., spreadman.

Portland Pipe Line Co. (Montreal Pipe Line Co.).—68 miles, 18-in., contracted, Canadian boundary to Montreal; Fred Mannix, contractor of Section 3.

Service Pipe Line Co.—25 miles, 8-in., under way, Beaver Creek and Riverton, Wyo.; Vaughn & Taylor Construction Co.

Shell Pipe Line Corp.—39 miles, 10-in., under way, McCamey to Kemper, Tex.; McVean & Roberts, contractor.

Texas-New Mexico Pipe Line Co.—16½ miles, 10-in., under way, Scurry County, Texas; O. R. Burden, contractor, Bill Price, spreadman.

West Coast Pipe Line Co.—20-in., planned, Permian basin, West Texas, to California.

Products Pipe Lines

Great Lakes Pipe Line Co.—39 miles, 12-in., under way, Hawarden, Iowa, to Sioux Falls, S. D.; Midwestern Constructors, Inc., contractor, R. C. Stanley, Canton, S. D.

Great Lakes Pipe Line Co.—355 miles, 12-in., authorized, Kansas City through Omaha and Sioux City, Iowa, to Sioux Falls, S. D.

Phillips Petroleum Co.—281 miles, 10-in., proposed, Borger, Tex., to Yale, Okla.

Phillips Petroleum Co. and Shamrock Oil & Gas Co.—155 miles, 6-in., planned, extension on 600-mile line at Phillips, Tex., via La Junta, to Denver.

Pure Transportation Co.—100 miles, 6-in., proposed, Heath to Dayton, Ohio.

Salt Lake Pipe Line Co.—242 miles, 6-8-in., under way, Boise, Idaho, to Pasco, Wash. Completion date, December 1950.

Salt Lake Pipe Line Co.—140 miles, 8-in., contracted Boise, to Baker, Idaho; Bechtel Corp., contractor.

Salt Lake Pipe Line Co.—Contracted, Macco Corp., and Morrison-Knudson Co., Inc.

Salt Lake Pipe Line Co.—120 miles, 6-8-in., under way, Baker, Ore., to Pasco, Wash. Completed August 8, 1950; Pacific Pipeline & Engineers, Ltd., contractor, L. E. Robertson, LaGrande, Ore., spreadman.

Standard Oil Co. (Ohio) and Shell Oil Co.—56 miles, 8-in., under way, Lima to Springfield, Ohio; Tulsa Construction Co., contractor.

Susquehanna Pipe Line Co.—126 miles, 8⅝-in., under way, Toledo, Ohio, to Sarnia, Ont., Canada; H. L. Gentry Construction Co., contractor. James Mitchell, Toledo, Ohio, spreadman.

Natural-Gas Pipe Lines

Acme Natural Gas Co.—25½ miles, 10-in., contracted, Ellwood to Butler, Pa., to be completed December 15, 1950; Williams-Austin Co., contractor. Howard Bauer, Butler, Pa., spreadman.

Alabama-Tennessee Natural Gas Co.—35 miles, 8-in., authorized, Muscle Shoals to Decatur, Ala.

Atlantic Gulf Gas Co. (United Gas Pipe Line Co.).—1,530 miles, planned, Alabama-Florida-Georgia-South Carolina.

Central Kentucky Natural Gas Co.—42 miles, 20-in., under way, North Means compressor station to Foster, Ky; completion date December 15, 1950; Williams-Austin Co., contractor, Leman Creech, Mt. Sterling, Ky., spreadman.

Chicago District Pipe Line Co.—41 miles, 24-in., authorized, loop Calumet pipe line—Joliet, Ill., to Chicago, completion date December 1950.

City of Indianapolis, Inc.—22 miles, 16-in., proposed, Indianapolis to Panhandle Eastern Corp. system.

Coast Counties Gas & Electric Co.—40 miles, 3-4-8-in., considered, coast and valley region, California.

Coastal Pipe Line Co.—1,000 miles, planned, Texas to Norfolk, Va.

Commonwealth Natural Gas Corp.—84 miles, 12-in., contracted, Richmond to Newport News, Va.; Ray L. Smith, contractor.

Commonwealth Natural Gas Co.—20 miles, 8-in., contracted, James River to Newport News, Va.; Ray L. Smith, contractor.

Commonwealth Natural Gas Corp.—104 miles, 18-in., under way, Standardsville to near Petersburg, Va.; Ray L. Smith & Son, contractor, Don C. Smith, Orange, Va., spreadman.

Commonwealth Natural Gas Corp.—537 miles, 20-in., proposed, West Bend, Ky., to Norfolk, Va.

Consolidated Gas Utilities Corp.—41 miles, 12-in., planned, Enid to Blackwell, Okla., Marlow to Cement, Okla.

East Ohio Gas Co.—24 miles, 20-in., authorized, northeastern Ohio to near Petersburg to East Ohio's Austintown station near Youngstown.

East Tennessee Natural Gas Co.—100 miles, planned, lateral to be laid in 1950.

East Tennessee Gas Corp.—150 miles, 16-in., under way, Knoxville to Bristol, Tenn.

East Tennessee Natural Gas Co.—398 miles, 3-16-in., planned, Nashville to Chattanooga to Knoxville, Tenn., and laterals.

East Tennessee Natural Gas Co.—106 miles, 12-16-in., contracted, Lobelville to Tullahoma, Tenn.; Oman Construction Co., contractor.

East Tennessee Natural Gas Co.—130 miles, 12-in., under way, Athens, via Chattanooga,

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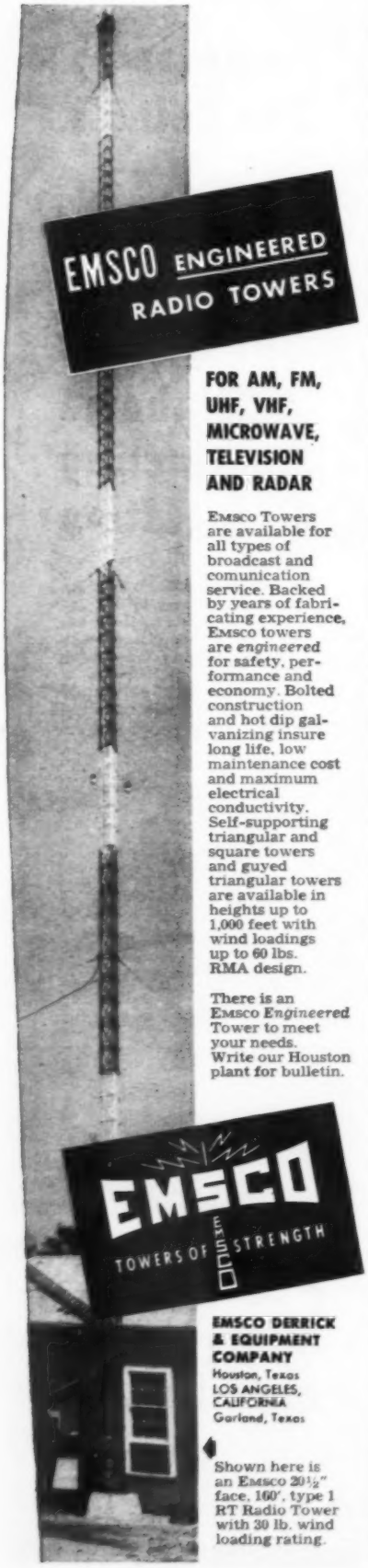

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East Tennessee Natural Gas Co.—120 miles, 12-in., planned, Chattanooga to Knoxville, Tenn.; Walters & Saigh Construction Co.

East Tennessee Natural Gas Co.—185 miles, 16-in., planned, Lobelville to Chattanooga, Tenn., Walters & Saigh Construction Co.

Eastern Natural Gas Corp.—292 miles, 24-in., proposed, Phoenixville, Pa., via New Haven and Hartford, Conn., Providence, R. I., Springfield, Mass., and Boston.

Egyptian Natural Gas Co.—80 miles, 6-8-in., planned, Norris City to Salem-Centralia, Ill., area.

El Paso Natural Gas Co.—352 miles, 30-in., under way, looping of 26-in., New Mexico-California line and connection with Pacific Gas & Electric Co. at Needles, Calif., to be completed November 1950.

El Paso Natural Gas Co.—450 miles, 24-in., authorized, San Juan basin, New Mexico, to Franconia, Ariz., to be completed November 1951 by company crews.

Home Gas Co.—70 miles, planned, Orange, Sullivan, Rockland, and Cattaraugus counties, New York.

Humble Oil & Refining Co.—50 miles, 8-in.; Trawick field to near Longview, Tex.; Trojan Construction Co., contractor.

Jersey Central Power & Light Co.—39 miles, 10-in., planned, New Jersey coast system of Texas Eastern Transmission Co.'s Big Inch.

Lion Oil Co.—60 miles, 6-2-in., gas gathering system in Scurry County, Texas. George Tucker Pipe Line Construction Co., contractor. J. O. Carter, spreadman.

Magnolia Petroleum Co.—60 miles, 4-24-in., gathering system in LaWard and Lolita fields, Texas; Henry L. Lemons & Co., contractor. W. A. Remington, spreadman.

Michigan Gas Storage Co.—150 miles, 20-in., planned, Chelsea terminal-Winterfield and Cranberry Lake, Mich.; Mahoney Contracting Co., contractor.

Michigan-Wisconsin Pipe Line Co.—197 miles, 6-18-in., under way, Milwaukee to Green Bay and Two Rivers, Wis.; G. G. Griffis Construction Co., contractor. F. K. Egan, Fond du Lac, Wis.

Mississippi River Fuel Corp.—40 miles, 18-in., authorized, Dubach to Perryville, La.

Montana-Dakota Utilities Co. and Montana-Wyoming Gas Pipe Line Co.—335 miles, 12¾-in., under way, Worland, Wyo., to Baker, Mont.; R. A. Conyes Construction Corp., contractor. Al Poggi, Hardin, Mont., superintendent.

New York State Natural Gas Corp.—42 miles, 20-in., Ohio-Pennsylvania line to Bakerstown, Pa.; Tulsa-Williams Co., contractor. O. L. Martin, Darlington, Pa., spreadman.

New York State Natural Gas Corp.—21 miles, 20-in., under way, Tonkin station to Bakerstown, Pa., to be completed December 1, 1950; Williams-Austin Co., contractor Ralph Gaddy, New Kensington, Pa., spreadman.

New York State Natural.—164 miles, 16-in., planned, Ithaca to Albany, N. Y.

New York State Natural Gas Corp.—70 miles, 20-in., planned, North Oakford, Pa. to Ohio state line.

Niagara Mohawk Power Corp.—85½ miles, 10-14-in., under way, Therm station, to Fulton, N. Y.; Williams-Austin Co., contractor. Howard Bauer, Nedrow, N. Y., spreadman.

Northern Natural Gas Co.—597 miles, 20-26-in., contracted, ten loops from Texas to northern Iowa.

Northern Natural Gas Co.—76 miles, 4 to 12-in., under way, gathering line in vicinity of Hugoton, Kans., Cheek Construction Co., contractor, Troy Cheek, Ulysses, Kans., superintendent.

Northern Natural Gas Co.—111 miles, 24-in., under way, Ogden, Iowa, to St. Paul, Minn.; R. B. Potashnick, contractor.

Northern Natural Gas Co.—75 miles, 26-in., under way, north of Beaver, Okla.; R. H. Fulton & Co., contractor of Loop 2. Merele Lewellen, Mead, Kans., spreadman.

Northern Natural Gas Co.—33 miles, 26-in., contracted, Mullinville, Kans., station; R. H. Fulton & Co., contractor of Loop 3.

Northern Natural Gas Co.—72½ miles,

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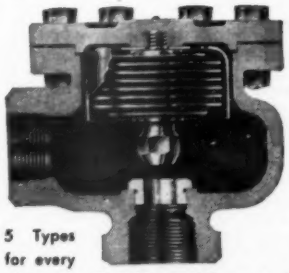

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26-in., under way, Bushton to Minneapolis, Kans.; R. H. Fulton & Co., contractor of Loop 4. M. L. Boyd, Salina, Kans., spreadman.

Northern Natural Gas Co.—155 miles, 20-in., contracted, Garden City to Bushton, Kans.; R. H. Fulton & Co., contractor of Loop 5. Jerry Nash, Garden City, Kans., spreadman.

Northern Natural Gas Co.—43 miles, 26-in., under way, Palmyra, Neb., station to Oakland, Iowa, station; Midwestern Construction Co., Inc., contractor of Loop 6. M. T. Wilhite, superintendent.

Northern Natural Gas Co.—31 miles, 26-in., under way, north of Ogden, Iowa; R. B. Potashnick Co., contractor of Loop 8. H. F. Carr, Ventura, Iowa, spreadman.

Northern Natural Gas Co.—41 miles, 26-in., contracted, northward from Ventura, Iowa, station; R. B. Potashnick Co., contractor of Loop 9.

Northern Natural Gas Co.—40 miles, 26-in., contracted, Ventura, Iowa, station; R. B. Potashnick, contractor of Loop 10.

Northern Natural Gas Co.—222 miles, 26-in., under way, Borger, Tex., to Nebraska line; R. H. Fulton & Co., contractor. M. C. Boyd, Ashland, Kans., spreadman.

Northwest Natural Gas Co.—750 miles, planned, Washington, Oregon, and Idaho.

Ohio Fuel Gas Co.—22 miles, 16-in., authorized, Dayton, Troy, Piqua, and Sidney, Ohio.

Pacific Gas & Electric Co.—47 miles, 8-in., authorized, Salinas to Kilig City, Calif.

Pacific Gas & Electric Co.—506 miles, 34-in., under way, Topock, Ariz., to Milpitas, Calif.; Bechtel-Price-Conyes Corp., contractor. R. L. Bowman, general superintendent.

Pacific Lighting Corp.—23 miles, 30-in., planned, Inglewood to Encino, Calif.

Pacific Lighting Corp.—41 miles, 30-in., planned, Puente to March Field, California, to be completed 1950.

Pacific Northwest Pipe Line Co.—400 miles, 22-in., gathering lines on Texas Gulf Coast to Pacific Northwest pipe line.

Pacific Northwest Pipe Line Corp.—2,175 miles, 26-in., authorized, Texas Gulf Coast to Pacific Northwest.

Panhandle Eastern Pipe Line Co.—356 miles, 26-in., authorized, looping in Texas, Oklahoma, Kansas, Missouri, Illinois, Indiana, Ohio, and Michigan.

Phillips Petroleum Co.—118 miles, 3-22-in., under way, Sherman and Hansford counties, Texas, gas-gathering system; Vaughn & Taylor Construction Co., Inc., Texhoma, Okla.

Piedmont Natural Gas Co.—1,350 miles, 30-in., planned, Greenville, Miss., to Carolinas.

Plains Natural Gas Co.—120 miles, 4-24-in., contracted, Oklahoma-Kansas area, Hugoton field, gathering system; Midwestern Constructors, Inc., (Arey-Phillips Construction Co.) contractor. T. S. Nunley, Liberal, Kans., chief inspector.

Potomac Gas Co.—18 miles, 16-in., planned, Dranesville to Arlington, Va.

Prince George's Gas Corp.—20 miles, 22-in., authorized between Chillum and Rockville, Md.

Roanoke Pipe Line Co.—30 miles, 8-in., authorized, Gala, Va., to Roanoke.

San Diego Gas & Electric Co.—53 miles, 16-in., planned, San Diego County, California.

San Diego Gas & Electric Corp. (Southern Counties Gas Co.)—85 miles, authorized San Diego, Riverside, and Moreno, California.

South Central Alabama Natural Gas Co., Inc.—150 miles, proposed, central Alabama

South Georgia Natural Gas Co.—248 miles, planned.

South Jersey Gas Co.—75 miles, 10-12-14-in., under way, Pleasantville, N. J., to Bustleton, Pa.; G. G. Griffis, Inc., contractor, Ray Abney, Millville, N. J., spreadman

South Jersey Gas Co.—14-in., under way Franklinville to Bridgeton, N. J.; G. G. Griffis, Inc., contractor.

Southwestern Michigan Gas Co.—55 miles, 12¾-in., proposed, Oakland County to Marysville, Mich.

Southern California Gas Co.—83 miles, 30-in., under way, Whitewater, Riverside County, to Puente, Los Angeles County, California; Midwestern Constructors, joint contract with Johnson Western Gunite—L. E. Dixon. John Work, Banning, Calif., superintendent.

Southern Counties Gas Co. of California.—81 miles, 20-in., authorized, looping.

Southern Natural Gas Co.—32 miles, 16-in., under way, Wetumpka to Tallassee, Ala.; completion due December 1; Sheehan Pipe Line Construction Co., contractor. C. M. Brown, spreadman.

Southern Natural Gas Co.—180 miles, 18-in., under way, Gwinville, Miss., to Selma, Ala.; Sheehan Pipe Line Construction Co., contractor. Jim Brown, Meridian, Miss., spreadman.

Southern Natural Gas Co.—24 miles, 24-in., under way, loops to Mississippi, Alabama, Georgia; Sheehan Pipe Line Construction Co., contractor. Jim Brown, R. H. Brown, spreadmen.

Southern Natural Gas Co.—85 miles, 18-in., under way, Mississippi-Alabama state line to Selma, Ala.; completion due November 15; Sheehan Pipe Line Co., contractor. C. M. Brown, spreadman.

Southern Natural Gas Co.—161 miles, 16-18-in., under way, Selma, Ala., to Elmore, Ala. Associated Pipeline Contractors, Inc., contractor. Lacy Walker and L. H. Gray, spreadmen.

Southern Natural Gas Co.—110 miles, 11-in., considered, extension.

Southern Natural Gas Co.—118 miles, 13-in., planned, extension.

Southern Natural Gas Co.—138 miles, 20-22-in., planned, Chattanooga, Tenn., to Lexington, Miss.

Southern Natural Gas Co.—171 miles, 16-planned, extension.

Southern Natural Gas Co.—225 miles, 16-in., planned, Colfax, Ga., extension.

Southern Natural Gas Co.—314 miles, 18-in., planned, extension.

Southern Natural Gas Co.—375 miles, 24-in., planned, Gwinville, Miss., to Atlanta, Ga.

Southern Union Gas Co.—78 miles, 8-10-

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14-in., planned, New Mexico loops and laterals.

Tennessee Gas Transmission Co.—102 miles 16-in., under way, Bayou Sale to Kinder, La.; Latex Construction Co., contractor. H. L. Leake, superintendent.

Tennessee Gas Transmission Co.—700 miles, 20-26-in., planned, Burnaugh, Ky., to Massachusetts including 400-mile line to Buffalo.

Tennessee Gas Transmission Co.—95 miles, 20-in., under way, Natchitoches to Kinder, La.; Latex Construction Co., contractor. F. A. Silar, superintendent.

Tennessee Gas Transmission Co.—992 miles, 30-in., planned, first 150 miles of loops to be laid at Monroe, La., Greenville, Miss., Midland and Portland, Tenn.

Tennessee Gas Transmission Co.—70 miles, 26-30 in., contracted, between Stations 104 and 110; Anderson Brothers Corp., contractor. E. C. McCoy and Arkie Hobson, Richmond, Ky., spreadmen.

Tennessee Gas Transmission Co.—174 miles, 30-in., under way, western Tennessee and Kentucky; Price-Morrison, contractor. Jack Hodges and R. L. McMillon, superintendents.

Tennessee Gas Transmission Co.—74 miles, 30-in., under way, from near Glasgow northeastward to near Lebanon, Ky; Morrison Construction Co., contractor. R. L. McMillon, Adamsville, Tenn., spreadman.

Tennessee Gas Transmission Co.—28 miles, 30-in., under way, near Scottsville, southwestward to near White House, Tenn.; Morrison Construction Co., contractor. R. L. McMillon, Adamsville, Tenn., spreadman.

Tennessee Gas Transmission Co.—99 miles, 30-in., under way, near Dickson, southwestward to near Selmer, Tenn.; H. C. Price, contractor. Jack Hodges, Linden, Tenn., spreadman.

Tennessee Gas Transmission Co.—170 miles, 26-30-in., contracted, Kentucky; Anderson Brothers Corp., contractor.

Texas Eastern Transmission Corp.—1,400 miles, 26-in., planned, Texas to Pittsburgh, loops.

Texas Gas Transmission Corp.—33 miles, 12-in., authorized, Slaughters, Ky., to Evansville, Ind.

Texas Gas Transmission Corp.—723 miles, 26-in., under way, Lisbon, La., to Middletown, Ohio.

Texas-Illinois Natural Gas Pipeline Co.—58 miles, 20-in., lateral from Joliet terminal to connection with Natural Gas Pipeline Co. of America near Volo, Ill.

Texas-Illinois Natural Gas Pipeline Co.—1,300 miles 30-in., under way, Corpus Christi area to Joliet, Ill.

Texas-Illinois Natural Gas Pipeline Co.—100 miles, 26-in., La Gloria to Refugio, Tex.; Midwestern Constructors, Inc., contractor of Schedule 1. M. T. Wilhite, superintendent.

Texas-Illinois Natural Gas Pipeline Co.—100 miles, 30-in., under way, Mississippi River to Effingham, Ill.; Midwestern Constructors, Inc., contractor of Schedule 11. John Work, superintendent.

Texas-Illinois Natural Gas Pipeline Co.—100 miles, 30-in., to start in 1951, Effingham to Sibley, Ill.; Midwestern Constructors, Inc., contractor to Schedule 12.

Texas-Illinois Natural Gas Pipeline Co.—93 miles, 30-in., to start in 1951; Sibley to Joliet, Ill.; Midwestern Constructors, Inc., contractor of Schedule 13.

Texas-Illinois Gas Pipe Line Corp.—409 miles, 30-in., contracted, Arkansas and Missouri; Bechtel Corp. A. M. Berlander, general superintendent.

Texas-Illinois Gas Pipe Line Corp.—126 miles, 30-in., contracted; H. C. Price, contractor. Work under way.

Texas-Illinois Gas Pipe Line Corp.—113 miles, 30-in., contracted; H. C. Price, contractor. Work under way.

Texas-Illinois Gas Pipe Line Corp.—97 miles, 26-in., contracted; H. C. Price, contractor. Work under way.

Texas-Illinois Gas Pipe Line Corp.—36 miles, 24-in., contracted; H. C. Price, contractor. Work under way.

Texas-Illinois Gas Pipe Line Corp.—38 miles, 12-in., contracted; H. C. Price, contractor. Work under way.

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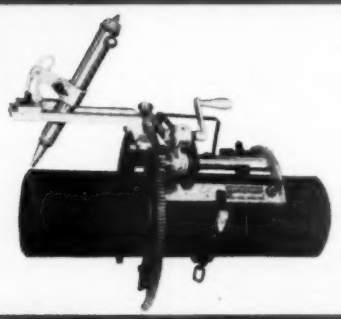

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Transcontinental Gas Pipe Line Corp.—1,840 miles, 30-in., under way, Rio Grande Valley, Texas, to New York City.

Transcontinental Gas Pipe Line Corp.—80 miles, 10-14-in., underway, Mercedes to south of Falfurrias, Tex.; Massey Construction Co., contractor of Schedule A.

Transcontinental Gas Pipe Line Corp.—106 miles, 24-in., under way, south af Falfurrias to Edna, Tex.; H. B. Zachry Co., contractor of Schedule B.

Transcontinental Gas Pipe Line Corp.—93 miles, 30-in., under way, Porters to Deweyville, Tex.; Texas Southern Contracting Co., contractor of Schedule D. Merle Tatum, Liberty, Tex., spreadman.

Transcontinental Gas Pipe Line Corp.—81 miles, 30-in., under way, Sabine River, to Eunice, La.; Anderson Bros. Corp., contractor of Schedule E.

Transcontinental Gas Pipe Line Corp.—100 miles, 30-in., under way, Catawba River, North Carolina, to North Carolina-Virginia boundary; R. H. Fulton & Co., contractor of Section 9. A. A. Corrigan and Clark Williams, superintendents.

Transcontinental Gas Pipe Line Corp.—86 miles, 30-in., under way, North Carolina-Virginia boundary to James River, Virginia; O. R. Smith Contracting Corp., contractor of Section 10. R. M. Jones, Altavista, Va., spreadman.

Transcontinental Gas Pipe Line Corp.—110 miles, 30-in., under way, James River, Virginia, to Potomac River, Virginia; O. R. Smith Contracting Corp., contractor of Section 11. C. C. Craig, Herndon, Va., spreadman.

Transcontinental Gas Pipe Line Corp.—75 miles, 30-in., contracted, Potomac River to Susquehanna River; Associated Pipe Line Contracting, Inc., contractor of Section 12. Cecil Rogers, Towson, Md., spreadman.

Transcontinental Gas Pipe Line Corp.—90 miles, 30-in., contracted, Susquehanna Pa., to Delaware River; Wunderlich & Griffis Construction Co., contractor of Section 13.

Transcontinental Gas Pipe Line Corp.—61 miles, 30-in., contracted, Delaware River to Hackensack River, New Jersey; Wunderlich & Griffis Construction Co., contractor of Section 14.

Transcontinental Gas Pipe Line Corp.—23 miles, 30-in., under way, Edgewater to Elizabeth, N. J.; Oklahoma Contracting Co., contractor to Schedule 15. Louis Visentine, Edgewater, N. J., superintendent.

Transcontinental Gas Pipe Line Corp.—98 miles, 6-14-in., under way, Wharton, Tex., area; Altgelt Construction Co., contractor, Texas Unit 1.

Transcontinental Gas Pipe Line Corp.—58 miles, 4-14-in., under way, El Campo, Tex., area; T & R Construction Co., contractor, Texas Unit 1.

Transcontinental Gas Pipe Line Corp.—38 miles, 4-8-in., under way, Sinton, Tex., area; Shanks & Eustace, Inc., contractor, Texas Unit 2.

Transcontinental Gas Pipe Line Corp.—61 miles, 6-10-in., under way, Dix, Tex., area; Victoria Oil Field Maintenance Co., contractor, Texas Unit 2.

Transcontinental Gas Pipe Line Corp.—50 miles, 18-20-in., under way, Eunice, La., to the south; Texas Southern Contracting Co., contractor, Texas Unit 2. Jim Reed, Crowley, La., spreadman.

Transcontinental Gas Pipe Line Corp.—380 miles, 8-16-in., planned, laterals to gas field.

Transcontinental Gas Pipe Line Corp.—85 miles, 4-14-in., under way, South Louisiana; Latex Construction Co., contractor. J. B. Latham, Vinton, La., spreadman.

Transcontinental Gas Pipe Line Corp.—78 miles, 30-in., contracted, Delaware River to southwest; Ray L. Smith & Son, Inc., contractor. Joe L. Work, Newton, Pa., spreadman.

Trunkline Gas Co.—278 miles, 20-in., contracted, Valley of Texas; R. H. Fulton & Co., contractor.

Trunkline Gas Co.—18 miles, 26-in., contracted, Mississippi, Tennessee, and Kentucky; R. H. Fulton & Co., contractor.

(Continued on page 403)

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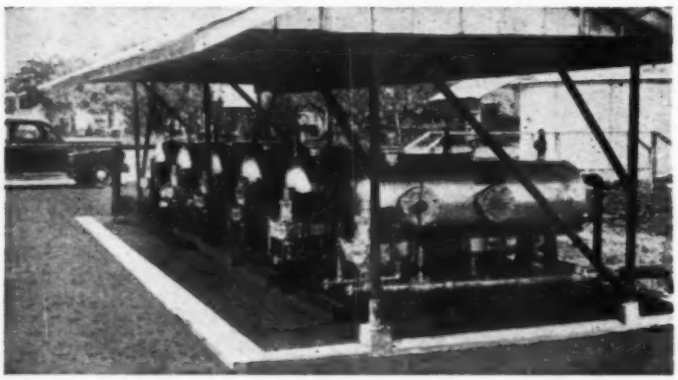

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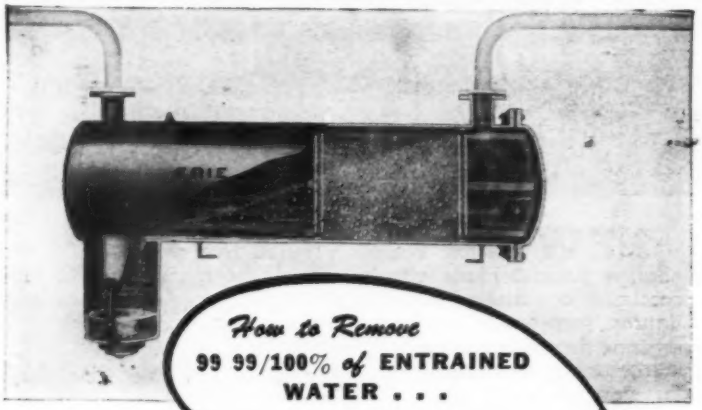

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NATURAL GAS

Colorado Interstate Hearing

WASHINGTON.—Further hearings will begin here November 30 before the Federal Power Commission in the proceedings involving Colorado Interstate Gas Co.'s proposed acquisition of the facilities of Canadian River Gas Co. Oral argument has been ordered, but no date fixed.

FPC last July authorized Colorado Interstate and Canadian River to build pipe-line facilities designed to carry additional natural gas to the Rocky Mountain market area. At that time, however, the commission reopened the record on the acquisition proposal for hearing of the testimony limited to the sole issue of the reasonableness of payments by Colorado to Southwestern Development Co., which controls Canadian River.

Colorado is proposing to acquire Canadian River's facilities in order to secure an adequate financing base for the construction program authorized in the July order. As consideration, Southwestern was to receive all the natural gasoline contained in the natural gas now owned by Canadian River in West Panhandle field and pay over to Colorado one-half of the gross receipts from the sale of the gasoline derived from the natural gas going to the Rocky Mountain area. Colorado on the other hand was to bear all costs of production, gathering, processing, and royalty payments. Furthermore, Southwestern was to receive 85 per cent of net revenue from gasoline associated with natural gas delivered to Natural Gas Pipeline Co. of America and destined primarily for the Chicago market.

In reopening the record for the purpose of determining the reasonableness of these payments, estimated at $800,000 to $1,000,000 a year, FPC said that Southwestern may have residual and other continuing rights in Canadian's properties which have not been shown on the record.

Mississippi Issue Cleared

WASHINGTON.—Mississippi River Fuel Corp., St. Louis, has ironed out its service problems at a Federal Power Commission hearing attended by 68 representatives of interested parties. The company owns and operates a transmission system extending from northern Louisiana through Arkansas and Missouri into Illinois.

Rules governing its delivery of natural gas to customers have been under long debate before the commission. Emergency disposition of the issue has been made for the period ending February 1952.

Attending the hearing were representatives of the Illinois Commerce Commission, the Missouri Public Service Commission, the Arkansas Public Service Commission, 6 utility customers, and 28 direct customers. The accepted rules cover Mississippi's interruptible rate schedules and contracts which are voided, and curtailment of firm sales to direct customers and distributors to specified volumes.

The transmission company is permitted to enlarge its service by constructing four compressor stations, and by operating three others already built to increase the system's sales capacity.

New Export Rule Pends

WASHINGTON.—Original owners of natural gas will no longer be compelled to file applications with the Federal Power Commission seeking export or import authority, under a pending amendment to the commission's procedure.

Final action on the proposed amendment is set for November 30. The new ruling would eliminate a requirement that the owner of a source of supply of natural gas who proposes to export or import natural gas, or who has entered or proposes to enter into a contract to supply natural gas to be exported or imported, shall be a necessary party to an application for the authorization required under the Natural Gas Act.

Appeal Breaks Record

WASHINGTON.—Northern Natural Gas Co., Omaha, has filed the largest rate-increase application yet made to the Federal Power Commission. Increased costs of rendering service are advanced as warranting a $9,300,000 raise for markets in Iowa, Kansas, Minnesota, Nebraska, and South Dakota, including the cities of Des Moines, Minneapolis, St. Paul, and Omaha. Service to approximately 728,000 customers is involved.

Northern Natural is increasing the capacity of its system from approximately 470 million cubic feet of natural gas daily to a planned flow of 600 million cubic feet daily. The expansion is designed to meet the needs of wholesale customers.

Originally Northern appealed for a $4,1000,000 increase, but while FPC was processing the application, service costs have expanded to a degree that an additional $5,200,000 of revenue is considered necessary. The new application concerns service to 28 gas-utility customers.

Illinois Storage Planned

CHICAGO.—Drilling of 50 shallow holes has been ordered by Texas Illinois Natural Gas Pipeline Co. as an exploratory venture seeking to discover an underground-storage area for natural gas near the Chicago market. Permission to start the investigatory drilling was reported by James F. Oates, Jr., chairman of the board.

Search will start in Kankakee County, 65 miles southwest of Chicago, along highway rights-of-way to determine the geological structure. The strata in that region have been folded in a dome-like formation indicating a deeper sandstone layer that might offer a practical storage field. Deeper holes will be drilled to the sandstone level. 1,600 ft. below ground.

If the formation lends its space to storage uses, natural gas will be pumped into this deposit under pressure, displacing the salt water now lodged there. Success with the proposed tests would open a storage program which at once would be extended to Gibson City, southwest of Kankakee.

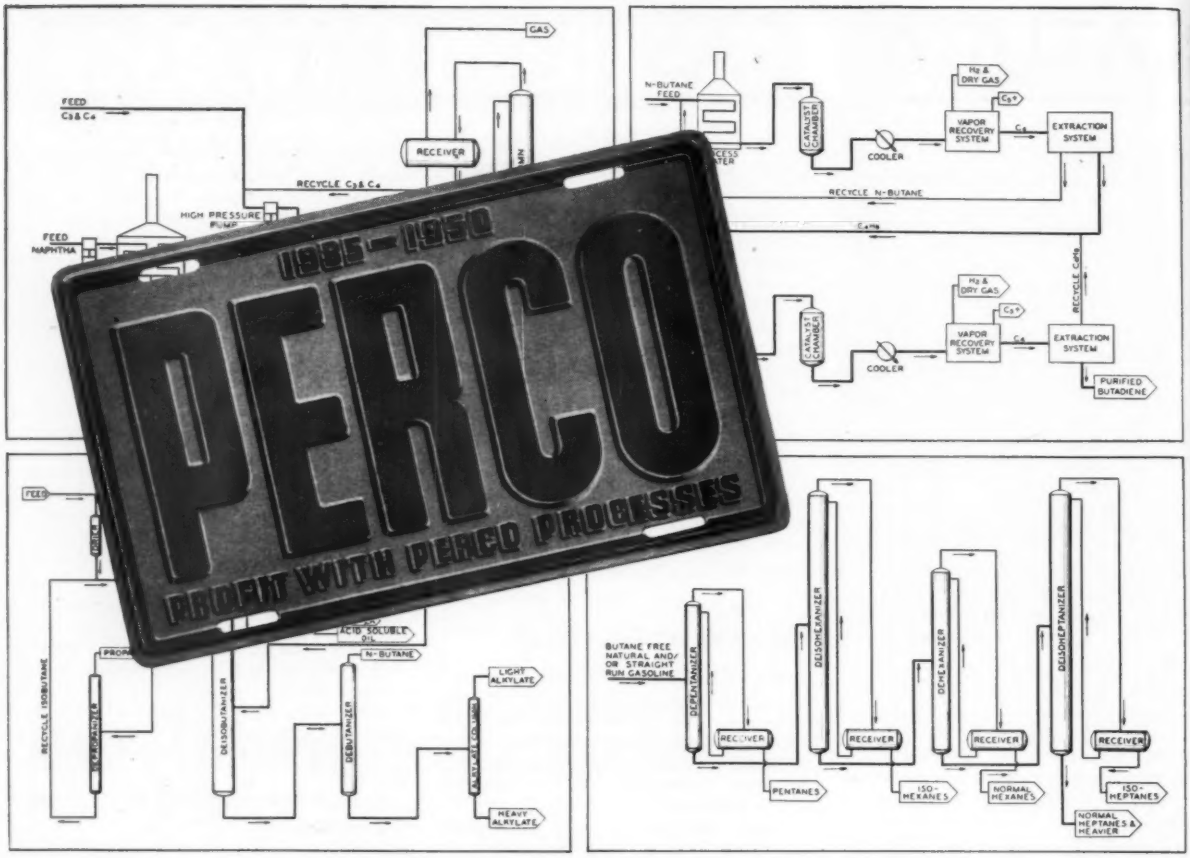
The storage system would ease the tight supply of natural gas which is now pressing the Chicago market. By loading the storage space with surplus natural gas during the off season, Texas Illinois can avoid the problem of increasing its facilities to meet the peak winter loads. Plans embrace the projected storage of billions of cubic feet of natural gas, an operation far more economical than the construction of additional pipe lines to meet the desired winter capacity even if Texas natural-gas reserves and scarce steel were available in the great quantities that would be required.

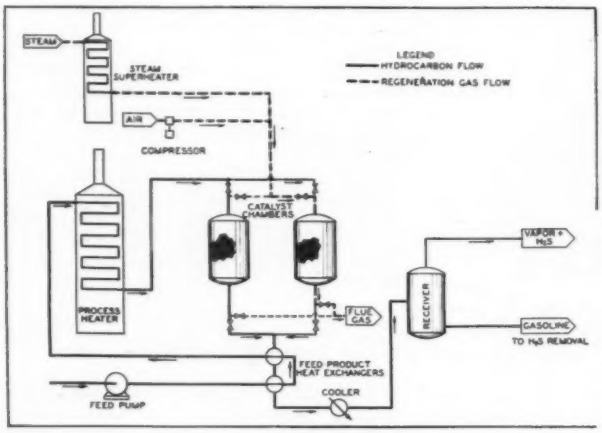
New Testing Methods

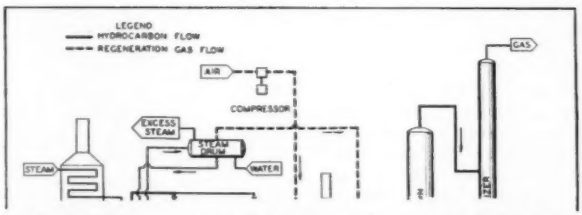
Two new tentative methods for testing natural gas have been submitted to the American Society for Testing Materials by the A.S.T.M. Committee D-3 on Gaseous Fuels.

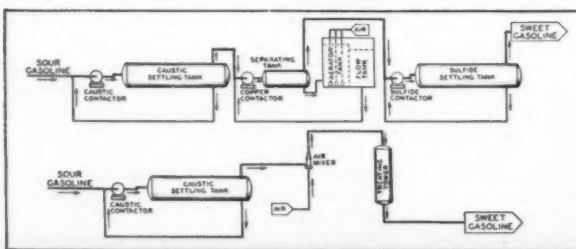
One method relates to the analysis of natural gas and related gas mixtures by the mass spectrometer, based on favorable results obtained in studying that instrument as an analytical tool. A second tentative method concerns a volumetric chemical method.

The two new tentatives are classified as Method of Test for Analysis of Natural Gases and Related Types of Gaseous Mixtures by the Mass Spectrometer (D 1137-50 T) and Method of Test for Analysis of Natural Gases by the Volumetric Chemical Method (D 1136-50 T).









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Kansas Refinery Expands

WICHITA.—Derby Oil Co. has entered a $2,000,000 expansion program with contracts let for a Socony-Vacuum Oil Co., Inc., Thermofor catalytic cracking unit, a Universal Oil Products Co. catalytic polymerization unit, and a gas-concentration plant.

Designed capacity of the new facilities will increase crude runs of the refinery up to 15,000 bbl. daily. The cracking unit will have a design capacity of 7,500 bbl. of virgin gas oil daily.

Basic process design of the installation is provided by Socony-Vacuum, U.O.P., and Fluor Corp., Ltd. Engineering and construction will be directed by Fluor. The new facilities are scheduled for completion in 11 months.

Ammonia Plant Completed

HOUSTON.—Dr. A. P. Beutel, vice president and general manager, Texas Division. Dow Chemical Co., has announced that new facilities for producing ammonia at Freeport have been completed, and tank-car quantities of anhydrous ammonia are now being shipped.

Initial construction operations on the $5,000,000 installation were started late in 1949. The Austin Co. was general contractor on the project.

Dr. Beutel stated that the Haber-Bosch process, also employed at Dow's Michigan and California plants, is being used at Freeport. Hydrogen, a byproduct from Dow's large Texas division chlorine facilities, is combined with nitrogen taken from the air to produce ammonia in its anhydrous form.

Dow currently has a $30,000,000 construction program under way at its two Texas plants located at Freeport and Velasco, 50 miles south of Houston. The company started operations in Texas in 1941 with a plant to manufacture magnesium from sea water. It has expanded since that time and now produces not only magnesium but numerous industrial chemicals, agricultural chemicals, and plastics.

Package Division Created

CHICAGO.—Calumet Refining Co., specializing in lubricating oils and lubricant fractions, has created a division of packaged products to handle its package operations. The plant will occupy the company's warehouse headquarters in Chicago, and the company's general offices and refinery bulk sales division will be moved to the Burnham, Ill., refinery, where new modern office facilities are under construction.

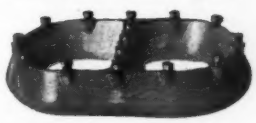
Installation wil include automatic drum-reconditioning equipment and high-speed canning machinery. Calumet has been a refiner and marketer for 35 years, its activities including crude production, refineries at Burnham and at Princeton, La., and a branch plant at Cleveland. Manager of the new division will be Guy N. Kinney, C. A. Harris, vice president and general manager, announced.

T.C.C. Unit Work Under Way

CORPUS CHRISTI.—Initial engineering work is under way on an 8,000 bbl. daily modified Thermofor catalytic cracking unit to be installed

This new mechanical-engineering and chemical laboratory building represents a 40 per cent increase in facilities at The Texas Co.'s main research center at Beacon, N. Y. The Beacon Laboratories, together with other Texaco research facilities at Montebello, Calif., and Port Arthur and Port Neches, Tex., are now conducting a total of 138 research projects for the company's refining department. The new Beacon laboratory represents a major project in the company's 10-year program of expanding all research facilities.

Efficient Stack Blower



When operating a boiler at 200% rated capacity, Inferno Stream-lined Stack Blower consumes only 2% of steam generated. Only 10% is consumed when operating at 425%. Less efficient stack blowers consume up to 20% of the steam generated to achieve same results. Blower has a malleable iron body capable of withstanding rough usage. Bulletin 22-A explains details. Write for a free copy today. Inferno products are sold through regular supply stores.

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at Taylor Refining Co.'s 22,500-bbl. refinery here.

Actual construction on the project is expected to start before the end of the year. The new unit will be similar to 10 units now under construction in six Socony-Vacuum Oil Co., Inc., refineries and one plant of Standard Oil Co. (Ohio). However, its charge capacity will be roughly half that of these units. Its rated capacity of 8,000 bbl. daily of fresh feed can be augmented by about 2,000 bbl. daily of cycle stock.

Jefferson Chemical Expands

Jefferson Chemical Co., Inc., will initiate manufacture of three new chemicals from refinery gas next year. Expansion of the company's plant at Port Neches, Tex., will provide the facilities for adding monoethanolamine, diethanolamine, and triethanolamine to the present line of ethylene oxide, ethylene glycol, diethylene glycol, and ethylene dichloride.

C. F. Braun & Co. has been awarded a contract for construction of a new processing unit for synthesizing the ethanolamines from ethylene oxide and other raw materials. Completion is scheduled for the second half of 1951. Organized in 1944, Jefferson Chemical is owned equally by The Texas Co. and American Cyanamid Co.

New Terminal Efficiency

BOSTON.—Modernization of its East Boston terminal is being completed by Socony-Vacuum Oil Co., Inc. Electrically driven pumps are replacing those operated by steam, speeding up the terminal facilities which serve a large section of the New England area with home-heating fuels, industrial fuels, aviation and motor gasolines, lubricants, and solvent naphthas.

Loading racks formerly located in different areas have been centralized and equipped with ticket-printing meters that automatically register the amounts pumped into the trucks. The new installations have increased the terminal efficiency by an estimated one-third.

Catalyst Plant Readied

SALT LAKE CITY.—New facilities of Filtrol Corp. are scheduled to start operations in January, increasing the company's catalyst production capacity by more than 25 per cent. The installation will make an improved catalyst for petroleum cracking, designed specially for high-octane gasoline. The plant is located to have ready access to clay deposits which constitute a major source of raw material.

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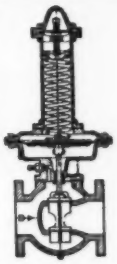

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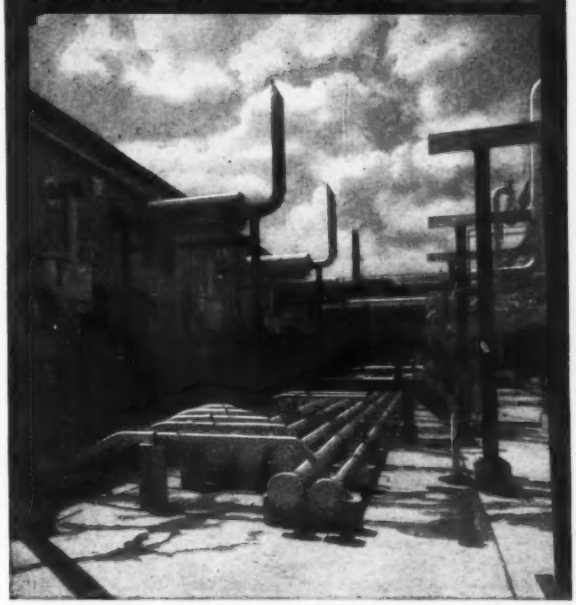

IN VENEZUELA

The photograph above shows three of the eight Maxim Silencers installed at the Creole Petroleum Corp., Mulata Crude Stabilization and Pressure Maintenance Plant in Venezuela. This compressor building houses eight 83-KVG Ingersoll-Rand Compressors with provision for increasing if necessary.

This is just another example of the broad acceptance of the Maxim name and Maxim products when silencing is required. Maxim's longer experience in the silencing field, backed by Maxim's progressive research and engineering staff, brings to each silencing problem the kind of specialized attention that means "more for your money." It's just common sense to "be sure it's a Maxim."

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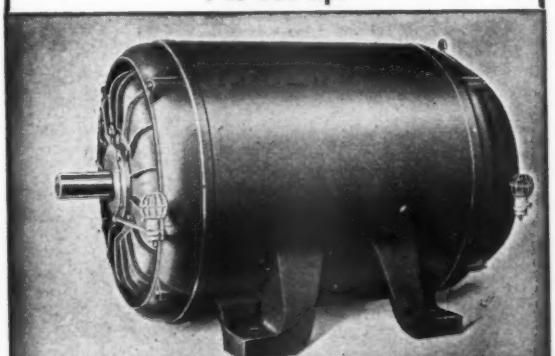

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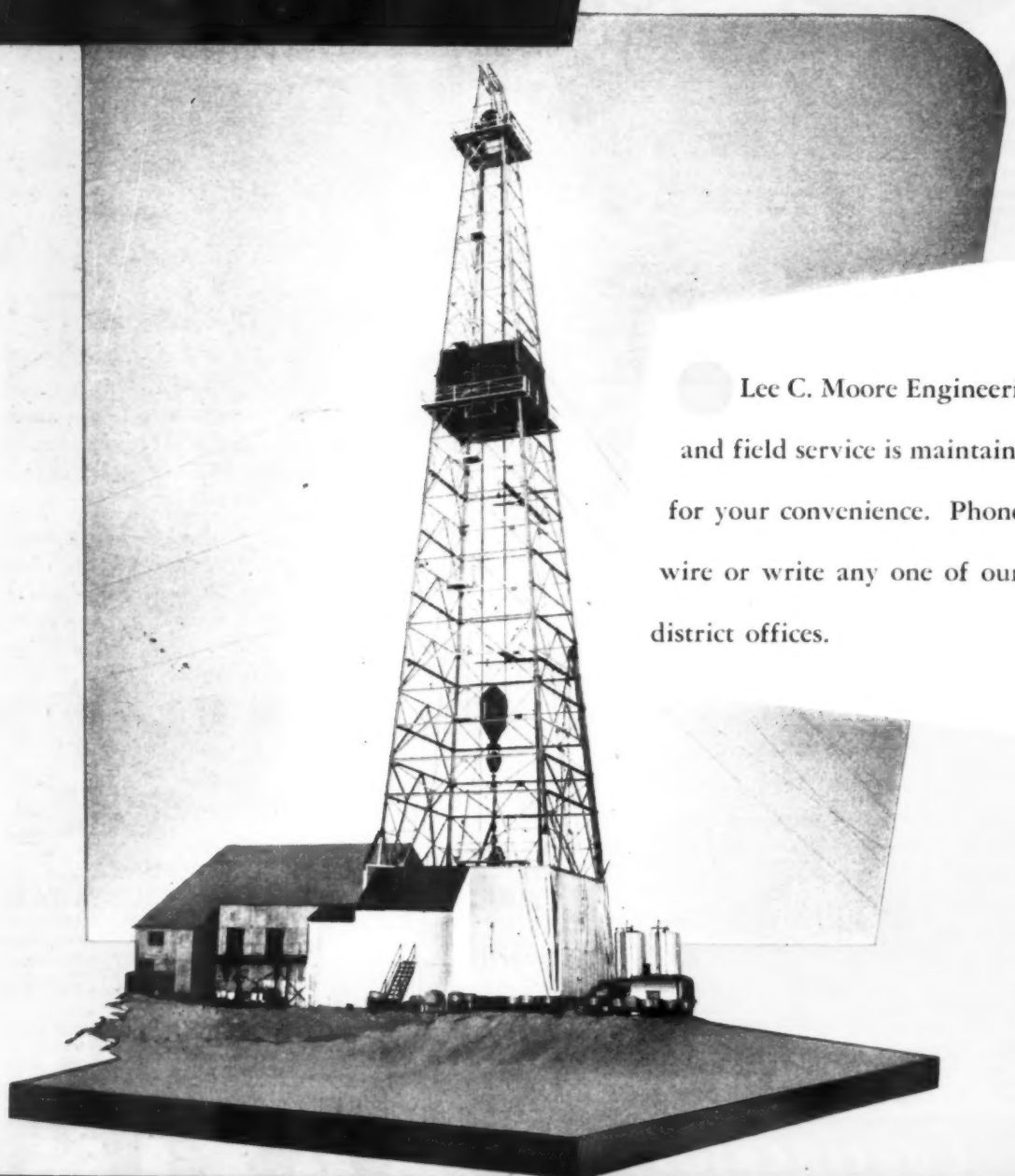

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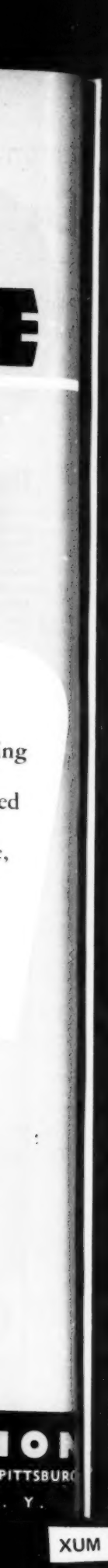

Among the Drilling Contractors

Pike Moves in to Drill on Mexican Contracts

Thomas P. Pike Drilling Co., Los Angeles, has opened offices in Reynosa, Mexico, to direct drilling wells under contract for Edwin W. Pauley, independent operator of Los Angeles. The latter has a number of concessions from Petroleos Mexicanos in the State of Tamaulipas. Joe G. Smith will be superintendent in charge of the drilling activities.

Pike's drilling equipment has been shipped to McAllen, Tex., and upon arrival there will be trucked across the Rio Grande to the first drill site. This will be about 35 miles up the Rio Grande and a few miles immediately south of the river. Pemex has developed a number of high-pressure oil and gas fields in this general area in the past 2 years.

Viersen & Cochran Get British American Jobs

Contracts for two wildcat tests which British American Oil Producing Co. has projected, one in Pontotoc County, and the other in Garfield County, Oklahoma, have been awarded to **Viersen & Cochran,** Okmulgee, Okla. The Pontotoc County test, 1 Gaar, SE SW SE 22-4n-2e, east of Stratford and 4 miles south of the Bebee pool, is contracted for 2,500 ft. or the Arbuckle lime. Rig has been moved in. The Garfield County contract is for 1 Rehorn, SE SW SW 34-24n-4w, 5 miles southeast of Hunter and 4½ miles north of the North Garber pool, nearest production. It is projected to 6,250 ft. to test the Wilcox sand.

Helmerich & Payne Rig To Drill 13,000-Ft. Test

Helmerich & Payne, Inc., Tulsa, is moving a large rotary rig from Carter County, southern Oklahoma, where it has just completed a well for Sinclair Oil & Gas Co., to a rank wildcat location in the northeastern corner of Beckham County, near the Roger Mills County line, in the extreme western part of the state, where the company has a contract for a 13,000-ft. test to be drilled for United Carbon Co. and Union Production Co.

Location for the test, 1 Clark, is in the northwest corner of 33-5s-2w, about 4 miles north of Elk City and about 7 miles from nearest production in the Elk City field. It is about 12 miles east of the location for another deep test, previously reported, which the company will drill for a group of operators headed by W. A. Delaney, Jr., of Ada, Okla. The latter test, 1 Ewton, is located in the C SE NW 17-11n-23w, southwest of Berlin in southern Roger Mills County. Contract is for 11,000 ft.

Flournoy & Williams Drilling Co., Hoisington, Kans., has a rig working for North American Producing Co. on a semiwildcat test north of the Eveleigh pool, northern Barton County, Kansas. Location is in the SW NW NW 1-18-14, on the operator's Phillips lease.

Robinson & Marshall Drilling Co., Shawnee, Okla., has a rig running for Globe Oil & Refining Co. in the Twin Lakes pool area, Seminole County, Oklahoma. Current operation is at 1 Fixico, NW NE NW 22-9n-7e.

Late contracts taken by **Noble Drilling Co.,** Tulsa, include two wildcat tests, one to be drilled for Continental Oil Co. at 1 Lewin, SE NE SE 17-3n-91w, near the Moffatt - Rio Blanco county line, northwestern Colorado, and the other for Stanolind Oil & Gas Co. at 1 Dorrance, SW NE NE 19-2s-4w, 2 miles south of the Velma pool, Stephens County, Oklahoma.

Trent Drilling Co., Tyler, Tex., has a string of tools working for National Associated Petroleum Co. in the Jacksonville field area in Cherokee County, East Texas. Current operation, 1 Ezell, contracted to 9,000 ft., is the second of a three-well drilling obligation in the area.

Campbell Drilling Co., Houston, has the drilling contract for a wildcat test which Placid Oil Co. is starting in Section 67-K, GH&SA Survey, 6 miles southeast of the Page Strawn field, Schleicher County, West Texas. Contract depth is 6,500 ft.

H. Waggoner is the contractor on a wildcat test being started for Rocket Oil & Gas Co. at 1 Miracle, NE NE SW 30-13n-7e, northwestern Okfuskee County, Oklahoma.

Luke Grace, Wichita Falls, Tex., has moved a rotary rig into the area 4 miles northwest of Eliasville, Young County, North Texas, where he will drill a projected 5,000-ft. wildcat test for Warren Oil Co. Location is on

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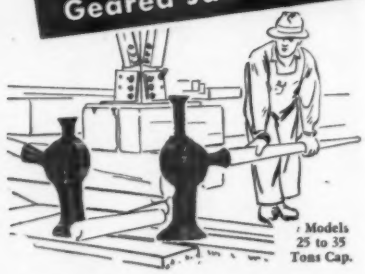

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Dan Lester, Jefferson, Tex., has the contract for a 6,800-ft. wildcat test to be drilled for Renwar Oil Corp. of Dallas at 1 Miller Jackson, located 7 miles south of Marshall, Harrison County, East Texas.

Dick Wegener, Oklahoma City, is moving in for a deep wildcat test located 2 miles northwest of Woodward, Woodward County, northwest Oklahoma, which he will drill for a group of operators headed by Clifton H. Davis of Oklahoma City. The test, 1 Ferguson Heirs, C NE SE 10-23n-21w, is contracted for a depth of 9,000 ft., or 100 ft. in the Mississippian.

R. L. Milam, Smackover, Ark., is drilling a 3,200-ft. wildcat test for James S. Patterson in the area 2 miles northeast of Earle, Critenden County, Arkansas. Location for the test, 2 Magness, is in 25-8n-6e.

Crow Drilling Co., Shreveport, has started operations at 1 Hopkins, an 8,300-ft. Travis Peak wildcat test which E. C. Casey of Tyler and C. B. Morris of Pittsburg, Tex., have projected for the area 3 miles northeast of Pittsburg, Camp County, northeastern Texas.

McAlester Fuel Co., Magnolia, Ark., has taken a contract for a 3,400-ft. test to be drilled for John R. Black at 1 Caraway, C NW SE 21-12 S-25w, 6 miles south of Washington, Hempstead County, Arkansas.

Falcon Seaboard Drilling Co., Tulsa, has the contract for a well to be drilled for Sterling Oil Co. of Oklahoma, Inc., in the Northeast Sporn pool, southern Payne County, Oklahoma, where development is being revived after a period of inactivity. Contract is for 1 Westfall, SE NE NW 15-17n-3e. Rig for the test is one which has been operating in the Butcher pool.

ROTARY RIGS IN OPERATION*

(United States and Western Canada)

Area—	Week ended 11-6-50	Change week ended 10-30-50	Change week ended 11-7-49
Gulf Coast	566	+ 3	+ 94
W. Tex.-N. M.	797	— 9	+182
Ark.-N. La.-E. Tex.	160	+ 8	+ 4
Oklahoma	280	+ 1	+ 47
Kansas-Nebraska	154	+12	+ 40
Illinois-Eastern	148	—13	+ 4
Rocky Mountains	130	+ 5	+ 16
Pacific Coast	140	+ 2	— 31
Total United States	2,375	+ 9	+356
Western Canada	119	— 3	+ 32
Total	2,494	+ 6	+388

*Courtesy Hughes Tool Co. Trends in drilling activity in the United States as a whole and the Gulf Coast and Arkansas-North Louisiana-East Texas areas are shown by charts on pages 404-405.

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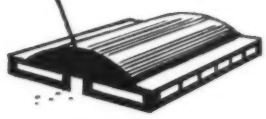

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A.P.I.'s activities cover every branch of the petroleum industry. Standardization is but one function of one division of this organization. Another important function of A.P.I.'s Division of Production has been the preparation of vocational-training publications, annual volumes on drilling and production practice, biennial volumes on A.P.I.'s own fundamental research projects, and special publications such as the one discussed on this page.

TYPICAL of the American Petroleum Institute's farsightedness and representative of the cooperative efforts that characterize and are responsible for the high state of efficiency of the petroleum industry is the A.P.I.-sponsored second edition of Secondary Recovery of Oil in the United States.

This compendium is the result of over 11 years of intensive study and investigation in which over 300 petroleum engineers and geologists participated. It has accomplished the principal objectives of A.P.I.'s Standing Committee on Secondary-Recovery Methods, which were to: (1) demonstrate that the petroleum industry has not been unmindful of its obligation to conserve the available oil resources of the nation, (2) assemble information and compile data on many existing secondary-recovery operations in the United States, (3) provide theoretical and practical information which can serve as a guide for the efficient recovery of oil, and (4) develop interest in the preservation of marginal properties and fields which might be abandoned unless some method for the stimulation of production is applied.

Designed to serve as a guide to the application of methods that will ultimately insure the maximum economic extraction of crude oil from underground reservoirs, this book gathers under one cover more than 50 papers prepared by leading oil-recovery authorities in the United States. These papers are grouped under five heads, as follows: General Considerations, Criteria for Determining Oil Fields' Susceptibility to Secondary-Recovery Methods, Development and Operation of Secondary-Recovery Projects, Description of Secondary-Recovery Operations in the United States, and Mining for Petroleum. The volume also contains a complete bibliography on secondary recovery (over 2,000 references), and an explanatory addenda. The 837 pages in this book include maps, cross-sections, graphs, tables, and diagrams. It is a handy reference for the experienced man moving into a new area and a text for the beginning student anywhere.

Secondary recovery of oil is an increasingly important subject. There is still a great deal to be learned about the most economical and thorough methods of recovering oil from a reservoir that has approached its economic production limit by primary recovery. A.P.I.'s publication of factual data and production methods now known will play a substantial role in speeding up the application of these methods and the development of new and improved ideas on how to reduce the amount of oil left in known reservoirs. The book's value might well be measured in barrels of recovered oil.

The second edition of Secondary Recovery of Oil in the United States is not merely a minor revision of the first edition published 8 years ago. This second edition contains many of the data of the first edition and its two supplements (all of which have been revised and, in part, rewritten), many new data, and an expanded bibliography.

Philip C. Ingalls.

HIGHLIGHTS OF WEEK'S DEVELOPMENTS

TEXAS GULF COAST.—Two oil and three gas-distillate sands have been found in Hawn Bros. 1 E. C. Schaefer, wildcat in James Duff Survey, A-153, DeWitt County. Oil was recovered on drill-stem tests run at 7,619½-22 ft. and 7,604-19 ft. Gas-distillate was recovered on drill-stem tests run at 7,584-87 ft., 7,587-94 ft., and 7,594-602 ft.

WEST TEXAS.—Fred M. Manning 1 Jones, Howard County wildcat in SW NW 5-25-H&TC, had discovery production from both Spraberry sand and the Pennsylvanian reef. Drill-stem tests of both formations yielded considerable clean oil. Possible Ellenburger oil has been found in the southeast area of Salt Creek field. In new O'Donnell Pennsylvanian field of Lynn County, Humble's 1 Dulin completed in Mississippian. Seven miles northwest of Tex Harvey (Spraberry) field, Houston Oil Co. 1 Golladay found oil on a drill-stem test of the same sand.

WEST CENTRAL TEXAS.—Sun Oil Co.'s 1 Featherstone, Nolan County Strawn discovery south of Sweetwater, made 30 bbl. of oil in 8 hours, swabbing and flowing, from open hole at 6,168-92 ft.

ROCKY MOUNTAIN AREA.—Several new operators made wildcat locations in the Denver-Julesburg Basin of Colorado, Wyoming, and Nebraska this week. General Petroleum Corp. has announced location for two new wells in the Slick Creek area, Washakie County, Wyoming, where it recently made a new discovery.

XUM

California

Potential Extensioner For Morales-Clayton Pool

LOS ANGELES.—Morales field's Clayton pool in the mountainous area north of western Cuyama Valley may have a ¼-mile northwest extension in the making. Discovered early last summer, a total of 11 Morales sand producers were completed to prove about 160 acres oil productive before development was suspended about 2 months ago.

The potential extensioner, Richfield Oil Corp. 1 Howard, is in SE SW 3-11n-28w. It topped the Morales at about 2,175 ft. and the Morales oil sand at around 2,310 ft. At 2,478 ft. it reportedly was still in the Morales. Last reports showed the operator was preparing to run an electrical log with total depth at 2,642 ft.

In Kern County and 2 miles southeast of oil production in Edison field, San Joaquin Drilling Co. was continuing its efforts to open shallow production at its 2 Di Giorgio. The wildcat topped an oil sand at 680 ft. and was drilled to 715 ft. It has been pumping mostly water with a trace of oil. In an attempt to increase the percentage of oil, the operator has been raising and lowering the tubing point. The test is located in SE SE 31-30s-30e.

Franco-Western Oil Co. apparently has opened production in the Schist at its step-out on the south end of Edison field. Located in 34-30s-29e, its 84-34 Frick topped the Chanac at 3,430 ft. and the Schist at 3,969 ft. Drilled to 4,075 ft. and with a packer set at 3,985 ft., on a 24-hour production test it pumped 65 bbl. of 23°-gravity crude and about 20 bbl. of water.

Among the new wildcats staked during the week was one in the Gould Hills area of Kern County. Drilled by Los Nietos Co. the test will be its 81-18 Richardson in NE 18-29s-21e. It will be about 1,200 ft. southeast of a test abandoned at 10,129 ft. by Los Nietos last June. Markers topped in that test included the Carneros at 7,909 ft., the Oceanic at 9,960 ft., and the Kreyenhagen at 10,080 ft.

Richfield Oil Corp. is preparing to drill two new wildcats in the Cuyama Valley area, one about 3 miles southeast of South Cuyama production and the second about 2½ miles east of Russell Ranch field in San Luis Obispo County. The former will be its 1 Lundstrom-Becher in 11-9n-26w. It will be located about ¾ mile south of Mohawk Petroleum Corp.'s recently abandoned test which found streaks of oil sand at 11,065-72 ft., after topping the Painted Rocks at 10,952 ft., and was carried to 11,175 ft. Richfield's other test will be called the 1 Humble-Priest and will be located in 34-11n-27w.

CALIFORNIA SUCCESSFUL WILDCAT

Los Angeles County: New pool in San Fernando-Aliso area—Los Nietos Co. 1 Edwards, 1-2n-16w, pumped at rate of 30 bbl. gross, 15 bbl. net, 23.9°-gravity oil, 26 psi. casing pressure, TD 5,722 ft., redrilled to 4,036 ft. and plugged back to 3,980 ft.

CALIFORNIA UNSUCCESSFUL WILDCATS

Kings County, Hanford area: Lake Oil Co. 1 M.R.M.-Phillips, 35-18s-22e, dry, TD 6,132 ft., elev. 254 ft.

Los Angeles County, Puente area: The Texas Co. 1 Puente Nine, 5-2s-10w, dry, TD 6,266 ft., elev. 325 ft.

West Antelope Valley area: Solar Oil Co., Inc. 1 Singer, 13-8n-15w, dry, TD 2,093 ft., elev. 2,445 ft.

Monterey County, Cholame area: Len Owens 1 Jordon, 19-24s-16e, dry, TD 2,150 ft., elev. 1,550 ft.

San Luis Obispo County, San Marcos Creek area: Chanslor-Canfield Midway Oil Co. 1 B & H, 32-25s-12e, dry, TD 4,982 ft., elev. 700 ft.

Solano County, Isleton area: The Texas Co. 1 Ryer-Prospect Comm., 26-5n-3e, dry, TD 4,760 ft., elev. 64 ft.

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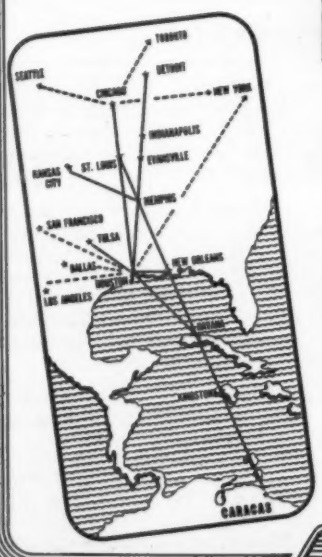

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Texas Gulf Coast

DeWitt County Wildcat Tests Oil and Distillate

HOUSTON.—A DeWitt County wildcat. Hawn Brothers 1 E. C. Schaefer, has recovered oil on two drill-stem tests and distillate on three drill-stem tests. Latest test on the well was made at 7,619½-22 ft., using ¼-in. chokes and 1,000 ft. of water cushion. Recovery was 720 ft. of 35.4°-gravity oil and 90 ft. of slightly salty water. Bottom-hole flowing pressure was 1,175 psi. On a previous drill-stem test run at 7,604-19 ft., using ¼-in. chokes, recovery upon pulling the tool was 5,370 ft. of 33°-gravity oil. Bottom-hole flowing pressure registered 2,885 psi. Condensate was recovered on drill-stem tests run at 7,584-87 ft., 7,587-94 ft. and 7,594-602 ft. This discovery is 2 miles east of Holly field production in the James Duff Survey, A-153. Operator will drill to contract depth of 9,000 ft.

In the dormant Moss Bluff Dome area of Liberty County, British-American Oil Producing Co. has a new oil producer at 1 W. P. H. McFadden et al, James McFadden Survey, A-76. The well flowed 64 bbl. of oil in 15 hours through a 7/64-in. choke, with 725 psi. tubing pressure. Hole is bottomed at 6,572 ft. with 5½-in. casing set at 6,335 ft. On a previous drill-stem test from 5,731½-38 ft., recovery was 2,500 ft. of oil, 120 ft. sand cut with oil and the 1,000-ft. water cushion.

Edwin L. Cox & Jake L. Hamon have run a 1-hour and 10-minute drill-stem test in their prospective Wilcox strike in Washington County. Operators tested 1 Bessie T. Hughes, E. R. Miller and W. R. Munson Leagues, in open hole at 9,317-24 ft., using ¼-in. choke, with recovery being 200 ft. of oil and 600 ft. of salt water. On another test at 9,367-72 ft., using ¼-in. choke, recovery was 32 bbl. of oil and 1 bbl. of salt water. Bottom-role flowing pressure was 2,170 psi. On a 30-minute test of open hole at 9,374-79 ft., working pressure was 500 psi., and the well flowed an ungaged amount of 36°-gravity oil. Operators pulled tool and recovered 1,980 ft. of oil with no salt water. Bottom-hole flowing pressure was 2,875 psi.

TEXAS GULF COAST (DISTRICTS 2 AND 3) SUCCESSFUL WILDCATS

Bee County: Gas discovery—C. G. Glasscock 1 Mrs. Sudie Scott, Jose Maria Urange 11 League Grant, 4 mi. N of Beeville, TD 4,600 ft., perf. 3,272-78 ft., IP: 2,800,000 cu. ft. of gas per day, ¼-in. choke, TP 850 psi., SITP 900 psi.

Hardin County: Oil discovery—J. K. Hughes Oil Co. 1 A. N. Blackwell, S. R. Brown Sur., A-542, TD 8,320 ft., top pay 7,170 ft., perf. 7,173-75 ft., IP: 53 bbl. oil per day, 6/64-in. choke, TP 1,675 psi., 36.4° gravity.

Refugio County: Oil discovery—Kirkwood & Co.-George K. Taggert A-1 St. John Heirs, Refugio Town Tract Grant, 3 mi. SE of Refugio, TD 7,519 ft., top pay 5,558 ft., perf. 5,558-66 ft., IP: 88 bbl. oil per day, ⅛-in. choke, 36° gravity, TP 580 psi.

Oil discovery—Arnold O. Morgan 1 F. J. Boehm, Esteban Lopez Sur., 4½ mi. SSE of Woodsboro, TD 7,856 ft., top pay 6,300 ft., perf. 6,302-06 ft., IP: 113 bbl. oil per day, 7/64-in. choke, 43° gravity, TP 105 psi., CP 1,350 psi.

TEXAS GULF COAST (DISTRICTS 2 AND 3) WILDCAT FAILURES

Fort Bend County: U. M. Harrison and F. H. Carpenter 1 Herman Hospital est., Jessie H. Cartwright Sur., 2½ mi. NW of Sugarland, dry, TD 8,520 ft.

Goliad County: Scurlock Oil Co. 1 Methodist Episcopal Church, W. P. Miller Sur., Berclair area, dry, TD 3,244 ft.

Montgomery County: Capital Co. 1 R. H. Berkley, Wm. Landrum Sur., A-21, 4 mi. NW of Montgomery, dry, TD 5,009 ft.

Southwest Texas

Tests Indicate Another Well for Dilworth Field

CORPUS CHRISTI.—H. R. Smith and American Republics Corp. 2 J. C. Dilworth, Jr., confirmation test for Dilworth field, McMullen has set 5½-in. to 5,496 ft. for production tests. The well was drilled to a total depth of 5,876 ft. with several indicated pay zones. Oil production was indicated during drilling operations and confirmed by drill-stem tests at 5,292-354 ft., 5,420-24 ft., and 5,424-40 ft. The same operators are reported to be making preparations for another well in the same area.

In Atascosa County, Lone Star Producing Co. 1 Sara E. Ferry, I&GN Survey 1, Abstract 699, is drilling ahead after testing some gas on drill-stem test. The test was run with packer set at 5,842 ft. with recovery being nine stands of rat hole mud, some of which was slightly gas cut. This wildcat is contracted to 8,500 ft. or the Edwards lime.

LaGloria Corp. has run a potential gage on its new dual oil and gas-condensate-discovery well for "Harvey field" in San Patricio County. The well, 1 J. H. Harvey, was gaged for 184 bbl. of 43.6°-gravity oil per day through perforations at 8,208-10 ft. Operators also perforated from 8,839-60 ft. in a gas-condensate sand and are waiting on potential. The discovery is located 5 miles northeast of Midway field in Block 9 of the Rincon Road Subdivision.

Sunray Oil Corp. is at a total depth of 10,006 ft. in the 1 J. O. Walker, a wildcat test on the east flank of the old Carolina-Texas field, Webb County. Sidewall samples were taken at 9,523, 9,520, 9,365, 9,364, 9,362, 9,352, 9,349, and 9,313 ft., with no shows. The wildcat is located in Survey 634, 10 miles northeast of Oilton.

Also in Webb County, 4 miles west of Moca field, Magnolia Petroleum Co. is rigging up to drill 1 Carl Newton Estate, a 2,000-ft. wildcat test in the Hooper & Wade Survey 481, Abstract 1,416.

SOUTHWEST TEXAS (DISTRICTS 1 AND 4) SUCCESSFUL WILDCATS

Bastrop County: Oil discovery—Adams & Jackson 1 H. P. Duran, A. Flint Sur., 2 mi. SW of Red Rock, top pay 2,164 ft., TD 2,237 ft., perf. 2,164-82 ft., IP: 13 bbl. oil per day, 42° gravity.

Hidalgo County: Gas-condensate discovery Taylor Refining Co. and Mayfair Minerals, Inc., 1 Pearl Keirn Unit, Lot 12, Block 7, Hidalgo Canal Subd., Porcion 64, TD 10,270 ft., perf. 9,010-375 ft., IP: 15,000,000 cu. ft. of gas per day on open flow, plus 10 bbl. 51.8°-gravity condensate per M.c.f. of gas, SITP 2,919 psi. On 3/16-in. choke, IP: 2,146,000 cu. ft. of gas per day, TP 2,572 psi.

Milam County: Oil discovery—G. A. Wilson 1 H. P. Culpepper, B. W. Holtzclaw Sur., 8 mi. NW of Rockdale, TD 496 ft., top pay 341 ft., perf. 341-61 ft., IP: 6 bbl. oil per day on pump, 42°-gravity.

San Patricio County: Oil discovery, "Harvey"—La Gloria Corp. 1 J. H. Harvey, Block 9, Rincon Road Subd., 3½ mi. NE of Gregory, dual completion, perf. 8,208-10 ft., IP: 184 bbl. oil per day, 11/64-in. choke, 43.6° gravity, perf. 8,839-60 ft., no gage on condensate, top pay 8,204 ft.

Oil discovery—Union Oil Co. of California 2 R. H. Welder, H. O'Neill Sur., A-210, 4 mi. N NW of Taft, top pay 4,124 ft., perf. 4,124-26 ft., TD 7,995 ft., IP: 40 bbl. oil per day, 18/64-in. choke, TP 100 psi., 21.7° gravity.

Travis County: Oil discovery—Anderson-Prichard Oil Corp. 2 Joe A. Martin est., Michael Green Sur., 1 mi. E of Elroy, top Serpentine sand pay 650 ft., TD 662 ft., open hole 650-62 ft., IP: 81 bbl. oil per day on pump, 35° gravity.

SOUTHWEST TEXAS (DISTRICTS 1 AND 4) WILDCAT FAILURES

Caldwell County: B. & S. Drilling Co., Inc.

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1 Icie Reed, B. G. Ridens Sur., 2 mi. W of McMahan, dry, TD 2,842 ft.

W. B. Osborn 1 W. N. Watkins, D. Benton Sur., 4 mi. NE of Lockhart, dry, TD 2,156 ft.

Duval County: W. D. Kennard et al 2 Duval County Ranch Co., Julian Palacios Sur. 55, 17 mi. SW of Freer, dry, TD 1,446 ft.

Frio County: Milam Drilling Co. 1 Marn McLean, C. H. Devilbiss Sur. 24, A-1322, 6 mi. W of Hinds, dry, TD 6,250 ft.

McMullen County: C. P. Burton 1 G. A. Lowrance, AB&M Sur. 191, A-508, 6 mi. S of Ezzell field, dry, TD 2,445 ft.

Zapata County: E. A. Bowles 1-C Anastacio Garcia, Charco Redondo Grant, 23 mi. NE of Zapata, dry, TD 1,010 ft.

Rocky Mountain

Operators Ignore Threats Of Old Man Winter

DENVER. — The Rocky Mountain region this week had its first general storm of the winter after good weather through the fall. New operators to the region had expected drilling to slow or stop but, to the contrary, new locations during the week increased throughout all Rocky Mountain states. In seven Rocky Mountain states there were 42 new locations announced, with drilling planned in each of the states through the winter. During past years the percentage of wildcat drilling has decreased in winter months, but the percentage is expected to increase during the 1950-1951 winter season due to increased exploratory drilling throughout the Denver-Julesburg Basin.

New operators this week entered the Denver-Julesburg Basin play. Rock Hill Oil Co. of San Antonio, Tex., and Twin Oil Co. of Dallas, Tex., announced location for 1 Narjes, NE SW NW 11-17n-49w, Morrill County, Nebraska. Ryan Oil Co. of Evansville, Ind., is now below 1,500 ft. at 1 Wood Land Co., NE NE SE 11-7n-48w, a wildcat in the Dailey area, Logan County, Colorado. Ryan has announced a wildcat program of six wells in the Denver-Julesburg Basin and has made location for a second test at 1 Scheel, C NE SW 21-16n-61w, Laramie County, Wyoming. The latter will be an 8,500-ft. test. H. C. Arnold of Tulsa is preparing to move in rotary for a wildcat on a Shell Oil Co. farmout block in Perkins County, Nebraska. Several other exploratory wells are now in the planning stage for this basin.

In Wyoming General Petroleum Corp. has announced location for two new wells in the Slick Creek area, Washakie County, where the company recently made an exceptionally good deep Phosphoria discovery. Well 44-32-P, SE SE NW 32-47n-92w, is ½ mile west of the discovery and 44-34-G, SE SE NW 34-47n-92w, is 1½ miles east of the discovery well. The discovery was completed flowing 634 bbl. of oil daily through choke, natural, from the Phosphoria zone. Previous Phosphoria completions in the Worland area, north of Slick Creek, and at South Fork, south of Slick Creek, were heavily acidized prior to completion.

WYOMING WILDCAT FAILURE

Carbon County, Muddy Creek: Amerada Petroleum Corp. 1 Universal-Shirley, SE SE NW 21-26n-80w; TD 2,780 ft., dry. Sundance 855 ft., Alcova 1,410 ft., Red Beds 1,440 ft., Tensleep 2,354 ft., Amsden 2,745 ft.

COLORADO WILDCAT SUCCESS

Morgan County, Lee pool: J. M. Huber Corp. 1 Govt.-Smith, SE SW NW 1-2n-57w; TD 5,536 ft., Dual completion, flowed 4,936 M.c.f. gas daily from Muddy and 7,440 M.c.f. gas daily from Dakota. Muddy 5,440 ft., Dakota 5,519 ft., perf. 3 holes 5,443-44 ft. in 7-in. casing set at 5,520 ft. and 12 holes per foot 5,442-55 ft.

Kansas

Scott County Wildcat Shows Oil in Lansing

PROMISING oil showings have been obtained in a rank wildcat test in Scott County, in the western part of the state. The wildcat is Herndon Drilling Co. 1 Rueter, NE NE NE 25-18-32, 5 miles southeast of Scott City. Nearest production of any kind is the small, shallow Shallow Water pool, 15 miles to the southwest. Scott County is in the heart of the vast, little explored region west of the Central Kansas Uplift trend of production, and east and north of the widespread Hugoton gas producing area. Hugoton gas production is about 20 miles to the south of the Scott County test.

Showings were in the Lansing section, top of which was logged at 3,878 ft. (—1,911 ft.). Best showings were in an interval at 4,001-31 ft., where the pipe filled 1,650 ft. of clean oil and 60 ft. of water-cut mud during a 60-minute drill-stem test. Indicated bottom-hole pressure was 1,030 ft. A second test made lower in the hole at 4,163-86 ft. got 680 ft. of sulfur water with the tester opened 60 minutes.

At latest report hole was to be deepend in exploration of lower, potentially production horizons.

In Seward County, in southwestern Kansas, another rank wildcat, Lansekan, Inc., 1 Kneeland, C NE SE 23-34-31, also has found oil and gas showings, but in lesser extent. These were in the basal Pennsylvanian section, in which, a drill-stem test, taking in an interval at 5,310-55 ft., had gas at the surface within 20 minutes after the tester was opened, and in the breakdown, yielded some free oil along with 130 ft. of gassy mud and 30 ft. of oily mud. Tester was open 60 minutes. The location, 12 miles east of the Hugoton field, is about 6 miles south of the Kismet pool and about the same distance northwest of the Adams Ranch pool, nearest production. Operators are drilling ahead.

Murfin Drilling Co. 1 Pelter, NW NW SE 26-21-14, ¾ mile southeast of the Van Winkle pool and west of the Southwest Pundsack pool, in northwestern Stafford County, swabbed at the rate of 10 bbl. of oil per hour while cleaning out after acidizing. Production is from the Lansing section with casing perforated at 3,669-73 ft. and 3,591-95 ft. Top of the Lansing is 3,412 ft. (—1,479 ft.). Arbuckle, logged at 3,777-97 ft., was dry.

About 1½ miles to the northeast of the Murfin well, Stanolind Oil & Gas Co. has completed its 1 Foster, NE NE SE 24-21-14, as the first Lansing producer and a ½-mile northwest extension for the Pundsack pool. Previous production in this pool has been from the deeper Arbuckle lime, which carried water in the Stanolind well. Plugged back from the Arbuckle, logged at 3,721-33 ft., and with casing perforated at 3,512-22 ft. in the Lansing, the well established a pumping potential of 118 bbl. per day. Top of the Lansing is 3,371 ft. (—1,441 ft.).

North American Producing Co. and associates 1 Woodside, NW NW NE 34-7-25, 9 miles from any production in western Graham County, had 30 ft. of oil-cut mud in the pipe following a 60-minute drill-stem test in Lansing lime, topped at 3,702 ft. The test took in an interval at 3,755-85 ft. Hole is being carried to the Arbuckle.

Peel & Hardman are opening a new pool in northeastern Trego County at their 1 Walz, SE SE SW 12-11-21. Testing Arbuckle lime, treated with 750 gal. of acid, the well swabbed at the rate of 10 bbl. of oil per hour. Total depth is 3,680 ft. with hole open below 3,666 ft. Top of the pay is 3,665 ft. (—1,571 ft.). Nearest production is 3 miles to the southeast in the Nicholson pool, in Ellis County.

KANSAS SUCCESSFUL WILDCAT

Barton County: Adair 1 Eveleigh, SE SE SE 31-17s-12w, elev. 1,811 ft., pumped 108 bbl. oil per day from Arbuckle at 3,336-43 ft., TD; anhydrite 705 ft., Topeka 2,945 ft., Lansing-Kansas City 3,086 ft.

KANSAS WILDCAT FAILURES

Graham County: Cook-Galloway 1 Zeigler, SW SW SW 35-10s-21w, elev. 2,098 ft., dry, TD 3,730 ft., anhydrite 1,590 ft., Topeka 3,134 ft., Heebner 3,343 ft., Toronto 3,365 ft., Lansing-Kansas City 3,383 ft., Sooy 3,696 ft., Arbuckle 3,717 ft.

Kingman County: Westgate-Greenland 1 Evans, NE NE SW 17-27s-5w, elev. 1,493 ft., dry, TD 4,305 ft., Mississippi chat 3,749 ft., Viola 4,125 ft., Simpson 4,195 ft., Arbuckle 4,288 ft.

McPherson County: Williams-Morine 1 Nelson, SW SE SE 25-17s-2w, dry, TD 2,737 ft., Kansas City 2,125 ft., Mississippi lime 2,712 ft.

Pratt County: Rine et al. 1 Hertlein, SE SE NW 5-29s-13w, elev. 1,951 ft., dry, TD 4,653 ft., Lansing-Kansas City 3,950 ft., Mississippi lime 4,429 ft., Viola 4,460 (?) ft., Simpson shale 4,519 ft., Simpson dolomite 4,531 ft., Simpson sand 4,540 ft., Arbuckle 4,634 ft.

Stafford County: Musgrove-Veeder 1 Weber, NE NE SW 19-21s-14w, elev. 1,944 ft., dry, TD 3,845 ft., anhydrite 855 ft., Heebner 3,287 ft., lime 3,391 ft., Lansing-Kansas City 3,405 ft., Sooy 3,664 ft., Viola 3,672 ft., Simpson 3,723 ft., Arbuckle 3,770 ft.

Henderson-Todd 1 Nolte, SE SE SE 7-21s-12w, elev. 1,854 ft., dry, TD 3,595 ft., anhydrite 670 ft., Topeka 2,819 ft., Heebner 3,098 ft., lime 3,226 ft., Lansing-Kansas City 3,244 ft., Sooy 3,483 ft.

Thomas County: Westgate-Greenland 1 Herbel, NE NW NE 30-9s-32w, elev. 3,100 ft., dry, TD 5,064 ft., anhydrite 2,640 ft., Topeka 3,738 ft., Heebner 4,030 ft., Dodge 4,053 ft., Lansing-Kansas City 4,069 ft., Fort Scott 4,468 ft., Mississippi lime 4,676 ft., Viola 4,913 ft., erosional Arbuckle 5,008 ft., Arbuckle 5,014 ft.

Trego County: Sohio et al. 1 Butler, NE NE NE 25-11s-22w, elev. 2,322 ft., dry, TD

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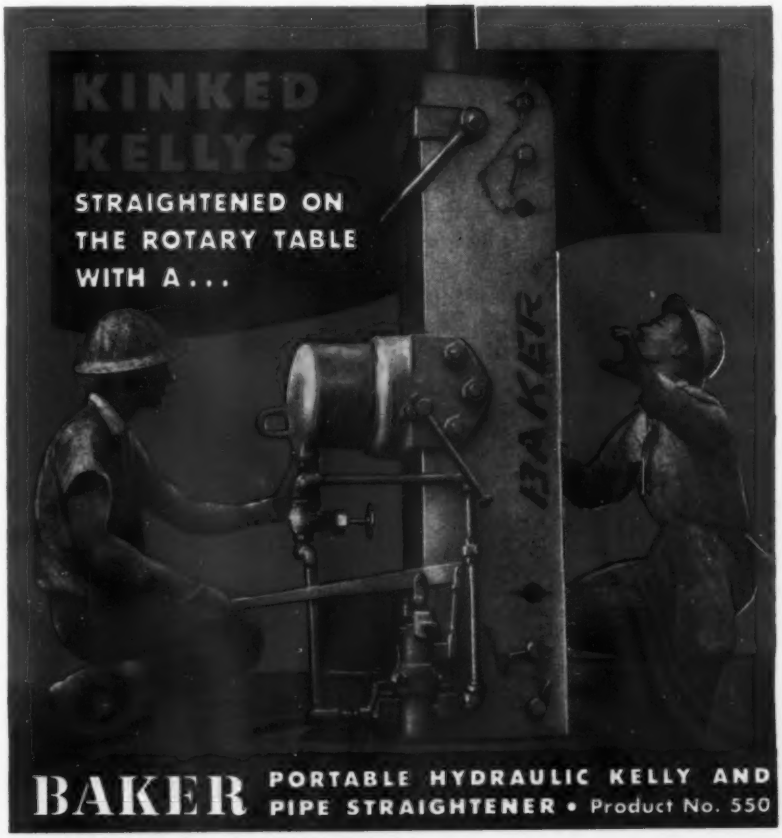

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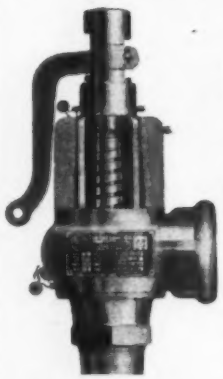

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Wabaunsee County: Carter 1 Burrow-Wingate "A," SE SE SE 17-14s-10e, elev. 1,528 ft., dry, TD 3,398 ft., Howard 1,025 ft., Topeka 1,090 ft., Heebner 1,405 ft., Lansing-Kansas City 1,685 ft., Kansas City 1,818 ft., Cherokee 2,281 ft., Burgess 2,650 ft., Mississippi chert 2,658 ft., Mississippi dolomite 2,666 ft., Kinderhook 2,974 ft., Hunton 3,138 ft., Maquoketa 3,307 ft., Viola 3,395 ft.

Ray Anderson et al. 1 Morris et al., elev. 1,097 ft., dry, TD 3,063 ft., Lansing 1,250 ft., Kansas City 1,390 ft., Burgess 2,259 ft., Mississippi chert 2,283 ft., Mississippi lime 2,286 ft., Kinderhook 2,594 ft., Hunton 2,795 ft., Maquoketa 2,972 ft., Viola 3,052 ft.

EASTERN NEBRASKA WILDCAT FAILURE

Richardson County: Landon 1 Seldman, CWL NE NW 33-1n-14e, elev. 1,200 (?) ft., dry, TD 2,810 ft., Howard 792 ft., Topeka 831 ft., Heebner 970 ft., Lansing-Kansas City 1,170 ft., Marmaton 1,525 ft., Mississippi lime 2,438 ft., Kinderhook 2,525 ft., Hunton 2,753 ft.

Eastern Texas

Kaufman's New Bacon Lime Pool Being Developed

DALLAS.—T. D. Humphrey was moving in rig to start drilling 4 Tharp as a west offset to 2 Tharp, Bacon limestone discovery 4 miles east of Kemp in Kaufman County. The same operator's 3 Tharp had total depth at 6,160 ft. and was waiting on pumping unit for completion tests in the Bacon lime. Completion of the latter well will make two producers from the Rodessa and one from the Woodbine sand, all of which are in the Cervantes Survey.

Delta Drilling Co. was rigging up at its 1 S. M. Taylor, a 9,000-ft. test 2 miles east of production in the Southeast Pickton field of Hopkins County.

E. A. Ellison of Tyler, was drilling ahead below 2,500 ft. at his 1 E. O. Williamson, 5,000-ft. wildcat test some 2½ miles south of Kemp in southeast Kaufman County. The area has had a number of tests, but none deeper than 3,000 ft., according to report.

EAST TEXAS (DISTRICTS 5, 6, & 6-P) WILDCAT FAILURES

Bowie County: W. M. Coats 1 W. L. Watson, James Watson Sur., 2½ mi. S Corley, dry, TD 4,500 ft.

Cass County: McAlester Fuel Co. 1-A Harry Golden Est., Wm. F. Weatherly Sur., 2 mi. N Douglasville, dry, TD 6,502 ft.

Denton County: B. D. Taylor 1 J. W. Brown, Hannah Estes Sur., A-389, 3½ mi. W Pilot Point, dry, TD 1,692 ft., Ellenburger 1,601 ft.

McLennan County: E. J. Muth 1 Freeman & Butler, R. Simpson Sur., A-808, 2½ mi. S Valley Mills, dry, TD 2,000 ft., elev. 732 ft., Travis Peak 890 ft., Pennsylvanian 1,130 ft.

Shelby County: American Republics Corp. 1 Jack McLeroy, Stephen English Sur., 7½ mi. NE Shelbyville, dry, TD 6,878 ft., Pettit 6,230-40 ft.

Wood County: R. J. Caraway and Andres V. Erwin 1 W. V. Morgan, R. E. Neill Sur., A-434, 6 mi. NW Quitman, dry, TD 6,700 ft.

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Permian Basin

Dual Horizon Discovery For Howard County

MIDLAND. — Discovery production from the Spraberry sand and the Pennsylvanian reef limestone were in prospect at Fred M. Manning, Inc. 1 Chester L. Jones, in the extreme northeast corner of Howard County.

First drill-stem test reported, in the Spraberry from 5,033-57 ft., recovered 1,140 ft. of clean oil, plus 60 ft. of oil and gas-cut mud in 3 hours. Hole was drilled ahead, entering the Pennsylvanian reef at 7,464 ft., or minus 5,158 ft. A 2-hour drill-stem test in the top 20 ft. of the reef had gas in 4 minutes and recovered 1,300 ft. of 42°-gravity oil, 200 ft. of oil and gas-cut mud and about 500 ft. of salt water.

In northwest Howard County, operators were testing at Brinkerhoff Drilling Co. 1 E. Jones. The well made a good showing in early tests, having gaged as much as 387 bbl. of oil in 20 hours through various sized chokes from open hole between 9,465-9,510 ft. The flow died following that test and could not be revived.

Hole was drilled ahead to 9,558 ft., and a drill-stem test from 9,370-9,558 ft. produced a flow averaging 15 bbl. of oil an hour for 4 hours and stopped. When drill pipe was pulled it was found that the bottom-hole choke was partially plugged. Tubing was being run for a production test at last report.

On the northwest side of the Kelly-Snyder field, Scurry County, Magnolia Petroleum Co. 1-F McDonald missed the pay in both the Canyon reef and Strawn but had some prospects in the Ellenburger. Through perforations at 8,033-41 ft., swabbing recovered about 2 bbl. of new oil an hour before acid treatment, and following acid treatment of 250 gal., recovery was 5 bbl. of new oil an hour.

Ellenburger oil was reported in the southeast extension area of Salt Creek field of Kent County. There, Humble Oil & Refining Co. 1 Lela Knight recovered 29 bbl. of 37°-gravity oil, plus the same amount of fluid, on a test of open hole at 7,518-32 ft.

Humble's Mississippian discovery in southeast Lynn County, 1 W. C. Dulin, was completed this week for 135 bbl. of oil a day, plus some salt water. The well is a new pay opener for O'Donnell - Pennsylvanian field and is one location northwest of the discovery. Pay section was 9,020-80 ft. and completion potential was on the pump. Total depth was 9,373 ft., in the Ellenburger, which carried water.

Union Oil Co. of California 1 Christova Stitt, second well for the new Cotten Pennsylvanian field southeast of Brownfield in Terry County, was ready for completion following tests from 9,915-10,115 ft. A drill-stem test from that interval had flowing oil in 20 minutes, which after cleaning into pits for 20 minutes, gaged 91 bbl. of oil in 1 hour. The new well is a south offset to the same operator's 1 Cotten, discovery well of the field, which completed in September for 1,812 bbl. daily at 9,998-10,073 ft. Union has another well drilling below 7,790 ft., in the new area, and Phillips Petroleum Co. 1 Cotten is drilling below 8,931 ft.

Magnolia 1 H. F. Timmerman, Midland County wildcat which marks a 3-mile extension to Parks field, or a new separate discovery, topped the Montoya at 12,445 ft., which was correlated 21 ft. high to the Parks well. A 3-hour drill-stem test from 12,396 to 12,461 ft., covering the base of the Silurian and top of the Montoya, had gas in 1 hour and 32 minutes, and recovered 280 ft. of oil and gas-cut mud.

Northwest of the Tex Harvey field, Midland County, Houston Oil Co. 1 Golladay drill-stem tested the Spraberry at 7,474-7,545 ft., recovering 180 ft. of oil and gas-cut mud in 4 hours.

J. S. Michael 1 Ellwood, southeast Mitchell County wildcat, reported tentative top on the Ellenburger at 7,214 ft. Drill-stem test from 7,247-77 ft., open 1 hour and 50 minutes, recovered 744 ft. of clean oil, 950 ft. of heavily oil and gas-cut mud and 340 ft. of water. The new prospector is surrounded by Ellenburger failures. Three miles east, Richardson & Bass had a dry hole at 7,675 ft.; 5 miles north, H. L. Hunt drilled dry to 7,475 ft.; 6 miles northwest is a 7,875 ft. Ellenburger failure, and 3 miles southwest of a 7,345-ft. failure drilled by Hurlbut.

Pan American Production Co. has a deep test slated for northwest Martin County, as the 1 F. D. Breedlove. Proposed depth is 13,000 ft. Drill site is 2 miles southeast of Stanolind Oil & Gas Co. 1 Mabee, dry, at 13,416 ft., in Ellenburger topped at 12,305 ft., and 4 miles northwest of Spartan Drilling Co.'s Walcott, Ellenburger failure at 12,798 ft. The latter well has been taken over by Ted Weiner and others, who have shot with nitro in the Spraberry sand, and were cleaning out to test.

WEST TEXAS (DISTRICTS 8 AND 7-C) SUCCESSFUL WILDCATS

Irion County: Wilshire Oil Co., Inc. 1-A Brooks, 21-3-H&TC, 6 mi. E Mertzon, TD 7,657 ft., PB 6,000 ft., elev. 2,315 ft., pay 5,950 ft., perforated 5,865-5,985 ft., IP flowed 24.3 bbl. 63°-gravity oil a day, ½-in. choke, GOR 49,000 cu. ft., TP 500-575 psi.

Schleicher County: Delta Gulf Drilling Co. 1 H. F. Thomson, 71-TT-TCRR, 1½ mi. SE Hulldale, TD 5,803 ft., elev. 2,300 ft., Strawn reef 5,775 ft., IP flowed 1,456 ft., 42°-gravity oil a day, ¾-in. choke, GOR 1,150 cu. ft., TP 175 psi.

Yoakum County: Dunigan Bros. 1 Henard, 367-D-J. H. Gibson Sur., 2½ mi. N Brahaney field, TD 5,285 ft., elev. 3,691 ft., San Andres pay 5,205 ft., IP pumped 57.7 bbl. 32°-gravity oil a day.

WEST TEXAS (DISTRICTS 8 AND 7-C) WILDCAT FAILURES

Andrews County: Anderson-Prichard Oil Corp. 1 Fasken "F-34," 34-41-2n-G&MMB&A, 13½ mi. SE Andrews, dry TD 4,910 ft., elev. 3,057 ft.

Borden County: Don Ameche et al 1 W. D Johnson, 45-32-5n-T&P, 8½ mi. SW Gail dry, TD 9,734 ft., elev. 2,514 ft., Spraberry sand 5,965 ft., Pennsylvanian reef 8,320 ft., Mississippian 9,210 ft., Devonian 9,668 ft., Ellenburger 9,704 ft.

British-American Oil Co. 1 W. T. Shockley, Blk. 1, E. A. Greghorn Sur. 5 dry, TD 9,052 ft., elev. 2,972 ft., Spraberry 6,358 ft., Dean 7,742 ft., Wolfcamp 7,982 ft., Pennsylvanian 8,749 ft

Coke County: Stekoll Petroleum Co. 1 J. B Glenn, C. C. Hudson Sub. 14, HE&WT Sur., 3½ mi. NE Tennyson, dry, TD 5,919 ft., elev. 1,947 ft., Palo Pinto 4,496 ft., Ellenburger 5,673 ft.

Concho County: Baker & Fidel 1 T. Y. Hill J. Frederick Sur. 1694, 3 mi. SW Doole dry, TD 2,367 ft., elev. 1,607 ft., Ellenburger 2,333 ft.

M. C. Moore 1 Robert Wilson, 76-8-H&TC 9½ mi. SW Eden, dry, TD 3,895 ft. elev. 2,319 ft., Strawn 3,650 ft., Ellenburger 3,775 ft., Hickory 3,888 ft.

Cochran County: C. W. Brown 1 C. W Brown-University, 13-42-University Lands, 14 mi. N Ozona, dry, TD 1,515 ft., elev. 2,619 ft., Queen sand 1,185 ft

Crockett County: T. V. Criswell and J. T Anderson 1 Continental-Shannon, 3-UV-GC&SF, 1 mi. N Vaughn field, dry, TD 1,505 ft., elev. 2,652 ft., Queen sand 1,000 ft.

C. P. Laubenheim 1 University, 12-39 University Lands, dry, TD 1,505 ft.

C. B. Laubenheim 1-B University, 13-39 University Lands, dry, 899 ft. in sand.

C. M. Page 1 George Harrell, 22-XX GC&SF, 29 mi. S Ozona, dry, TD 527 ft

Vickers & Yarbro 1 University, 19-39 University Lands, 17 mi. SE Barnhart dry, TD 940 ft.

Gaines County: Phil Reagan 1 Robertson 346-G-CCSD&RGNG, 4½ mi. S Denver City, dry, TD 8,160 ft., elev. 3,523 ft.

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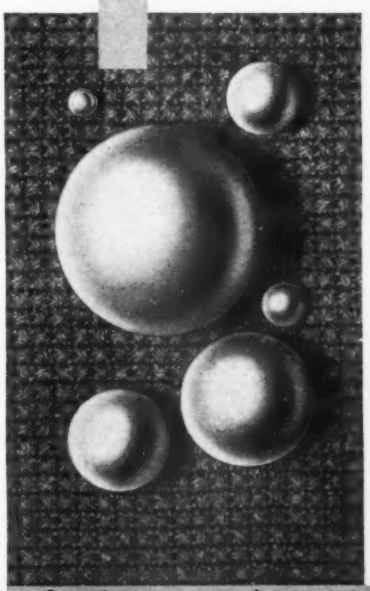

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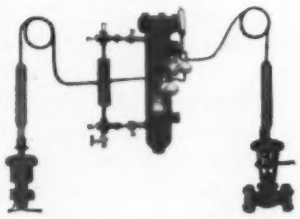

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Phil Reagan 2 Robertson, 346-G-CCSD&RGNG, dry, TD 5,390 ft.

Irion County: Douglas & Hollums 1 Ohio-Mayer, Sec. 1128, GC&SF, 2½ mi. NE Arden, dry, TD 965 ft., elev. 2,081 ft., San Andres 530 ft., Clear Fork 774 ft.

Kent County: Sunray Oil Corp. 1 W. A. Mays, 57-4-H&GN, 3½ mi. NE Cogdell field, dry, TD 7,562 ft., elev. 2,155 ft., Pennsylvanian reef 6,785 ft., Mississippian 7,275 ft., Ellenburger, by samples, 7,441 ft.

Lamb County: H. L. Hunt 1 Robertson, Labor 16, League 223, Collingsworth CSL, 1½ mi. N Sudan, dry, TD 9,055 ft., elev. 3,784 ft., San Andres 2,830 ft., Wolfcamp 7,030 ft., Mississippian 8,570 ft., Ellenburger 8,970 ft.

Mitchell County: J. W. Murchison 1 J. C. Womack, 8-26-H&TC, 3 mi. S Dunn field, dry, TD 8,338 ft., elev. 2,272 ft., Reef 7,695 ft., Mississippian 8,095 ft., Ellenburger 8,272 ft.

Pecos County: Cabot Carbon Co. 1 C. E. Marshall, 137-10-H&GN, 9 mi. W Girvin, dry, TD 4,033 ft., elev. 2,415 ft., San Andres 1,820 ft., Ellenburger 3,973 ft.

Childress Royalty Co. 1 J. S. Masterson "G," 116-10-H&GN, 5 mi. SE Buena Vista, dry, TD 2,056 ft.

Paul F. Lawlis 1 G. R. White, 11-Z-TCRR, 3 mi. N West Yates field, dry, TD 1,044 ft.

Runnels County: Anderson & Reynolds 1 Hugh Campbell, J. Bays Sur., 530-5/8, A-23, 4 mi. N Ballinger, dry, TD 4,612 ft., elev. 1,734 ft., Ellenburger 4,420 ft.

Schleicher County: National Associated Petroleum Co. 1 B. M. Boyd, 23-H-GH&SA, 19 mi. NE Page field, dry, TD 5,510 ft., elev. 2,361 ft., Strawn 4,675 ft., Ellenburger 5,220 ft.

Tom Green County: W. R. Powell 1 Mary March Compton, 25-4-H&TC, 10 mi. N San Angelo, dry, TD 722 ft.

SOUTHEAST NEW MEXICO

HOBBS.—Magnolia Petroleum Co. was assured of production at its 1 C. L. O'Brien "B," 1-9s-28e, Devonian wildcat 9 miles southwest of its Lightcap Devonian discovery. Top of the formation was 7,244 ft. A drill-stem test at 7,239-49 ft., open 3 hours and 4 minutes, had gas in 2 minutes which gaged 2,140,000 cu. ft. daily. Oil started flowing in 17 minutes and gaged 121.05 bbl. in 2 hours and 40 minutes. Gravity of the oil was 52.4°.

Operators then cored ahead to 7,259 ft., recovering 8 ft. of additional porosity, with good odor of oil, bleeding in the bottom 2 ft. A 3-hour test from 7,249-59 ft. produced a light blow of gas in 1 hour and recovered 220 ft. of heavily gas-cut mud. Recovery was not reported in coring ahead to 7,267 ft., but a 2-hour test from 7,256-67 ft. had gas in 5 minutes, and flowed an unestimated amount of oil, water and mud.

Magnolia 1 State "Z," 1½ miles northwest of the Lightcap, recovered drilling mud with no shows on a drill-stem test in the Ellenburger from 8,623-8,723 ft.

Ohio Fields

Big Gas Well From Clinton in Perry County

COLUMBUS.—Foraker Drilling Co. 2 Morrison-Lewis, Section 32, Harrison Township, Perry County, topped the Clinton at 3,730 ft. and drilled 35 ft. into the formation where an open flow of 1,000,000 cu. ft. of gas, natural, was recorded after blowing open for 4 hours. The well will not be drilled through the sand until later.

Status Development Co. completed a fair gasser on 1 P. M. Crum, Section 8, Sandy Township, Tuscarawas County. White Clinton, at 4,947-73 ft., gaged 500,000 cu. ft. natural, and 730,000 cu. ft. when shutin after shot.

L. S. McGrath extended the gas pool in the south center part of Parma Township, Cuyahoga County, ½ mile to the northwest. The 1 Emil Bicak, Lot 34, found the Newburg sand at 2,685-92 ft. with 275,000 cu. ft. natural.

Mid East Oil Co. attempted to extend New Castle pool in Coshocton County over into Section 21, but found the sand almost missing. On 1 D. R. Foster, the Clinton was logged at 3,133-39 ft. with no shows.

OHIO WILDCAT FAILURE

Coshocton County, New Castle Township: Mid East Oil Co. 1 D. R. Foster, Sec. 21, Clinton 3,133-39 ft., TD 3,195 ft.

South Louisiana

First Well in New Cox Bay Field Completed

NEW ORLEANS.—Richardson & Bass have made final completion on 2-H State 1,794-Orleans Levee District, 5-18s-16e, Plaquemines Parish, which will go on record as discovery of Cox Bay field. The well flowed 260 bbl. of 36.4°-gravity oil per day through 9/64-in. choke, with tubing pressure of 1,725 psi. Hole was drilled to total depth of 10,954 ft. and operators perforated from 9,710-15 and 9,717-20 ft. for production tests.

While the above well will be classed as the discovery for the field, it is producing from the same sands found in the operators' 1-H State Lease 1,794, 4-18s-16e, which is awaiting permission to dually complete as an oil and gas well.

Oil production has been confirmed in the new Opelousas field, St. Landry Parish, at Magnolia Petroleum Co. 1 O.S.L. Securi-

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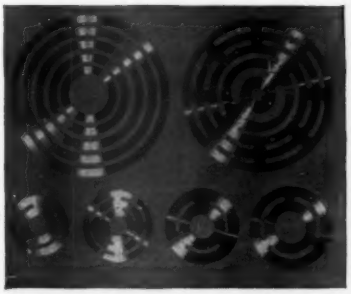

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ties, 59-6s-4e. The well came in flowing 221 bbl. of 50.2°-gravity condensate per day through 12/64-in. choke, with tubing pressure of 3,435 psi. Production is through perforations at 11,348-60 ft. Opelousas field was discovered by Magnolia 1 Alice B. Rozas, 41-6s-4e, which was completed earlier this year for 225 bbl. of condensate per day through perforations at 11,412-22 fe.

In Lafourche Parish, Placid Oil Co. 1 City of New Orleans, 22-23s-22e, wildcat 2 miles west of Bay Marchand, is drilling below 15,595 ft.

At an east offset to Superior Oil Co. 1-L Miami Corp., discovery well for Lake Misere field, Cameron Parish, Gulf Refining Co. is testing oil in a new sand. The well, Gulf 1-H Miami Corp., 35-13s-5w, tested an average of 60 bbl. of oil per day through ¼-in. choke, plus 2,000,000 cu. ft. of gas. Tubing pressure was 3,400 psi., and corrected gravity of the oil was 45.4°.

Approximately 25 miles off St. Mary Parish, Magnolia has completed its A-3 State Lease 843, Block 126, as an oiler, confirming production in that field. On potential, the well flowed 655 bbl. of 37.5°-gravity oil daily through a 13/64-in. choke. Tubing pressure was 2,120 psi. Production is through perforations at 11,372-92 ft. Operators have discovered four sands on the Block 126 structure.

SOUTH LOUISIANA SUCCESSFUL WILDCAT

Plaquemines Parish: New oil discovery, "Cox Bay"—Richardson & Bass 2-H State 1,794-Orleans Levee Dist., 5-18s-16e, TD 10,954 ft., top pay 9,710 ft., perf. 9,710-15 ft. and 9,717-20 ft., IP: 260 bbl. oil per day, 9/64-in. choke, TP 1,725 psi., 36.4° gravity.

SOUTH LOUISIANA WILDCAT FAILURES

Avoyelles Parish: Gulf Refining Co. 1 Ben J. Altheimer Estate et al, 13-4n-4e, 8½ mi. W of Argo, 2 mi. S Saline Lake field, dry, TD 6,900 ft.

Evangeline Parish: The Texas Co. 1 Valin Vidrine, 24-6s-2w, 3 mi. N of Tepetate field, dry, TD 12,406 ft.

St. Bernard Parish: Richardson & Bass 1-G Albert Ruiz, 136-14s-14e, 4 mi. S of Olivier, dry, TD 13,003 ft.

Terrebonne Parish: The Texas Co. 1-B Continental Land & Fur Co., Inc., 34-17s-12e, 9½ mi. S of Morgan City, dry, TD 12,505 ft.

North Central Texas

Stonewall County Wildcat Tests Oil from Penn Reef

WICHITA FALLS.—Seaboard Oil Co. of Delaware had a Pennsylvanian reef discovery in the southwest corner of Stonewall County, on the basis of drill-stem tests, and was waiting on orders after making electrical surveys.

The new prospector is Seaboard 1 W. F. Edwards, 15 miles southwest of Aspermont. Tentative top of the Pennsylvanian was 5,218 ft. First tests from 5,220-51 and 5,248-70 ft. yielded oil and gas-cut drilling mud but no free oil. A 2-hour test from 5,279-5,300 ft. had gas in 40 minutes and recovered 1,475 ft. of fluid, being 935 ft. of clean oil and 540 ft. of heavily oil and gas-cut mud. Bottom-hole flowing pressure was 550 psi., and 15-minute shut-in pressure reached 2,100 psi. Another source carried the test as being from 5,279-5,314 ft., total depth, with the same recovery. Operators were undecided on whether or not to drill deeper. The bottom 2 ft. was said to have drilled soft and yielded the best oil shows. Location is about 2 miles west and slightly south of Delta Drilling Co. 1 Sparks, dry at 6,582 ft.

Strawn production was opened in an old shallow area of northeast Young County at Charles J. Kleiner Estate, Turner Fiske & West 70-A W. C. Langston, 2½ miles south of Farmer. A drill-stem test from 3,520-25 ft., open 90 minutes, flowed oil but no estimate was made on production. Recovery in the pipe was 600 ft. of clean oil. Operators ran pipe to 3,521 ft. for completion.

In northeastern Young County, W. B. Hamilton 3 Pace & Strange completed for 106 bbl. of 44°-gravity oil a day, pumping, from pay at 3,126-30 ft. The well is a north offset to a dry hole to 3,648 ft., which is also between it and the Pace & Strange Strawn field.

Discovery production from a shallower pay section in Vogtsberger field south of Wichita Falls was found at Tom B. Medders 3-A Sturm estate, Block 4, German Emigration Co. Survey. The discovery was drilled to 4,684 ft. to the field's regular pay section, then plugged back to 3,550 ft. Completion potential was 173 bbl. of 42°-gravity oil a day, flowing through 20/64-in. choke, from pay at 3,527-43 ft.

NORTH CENTRAL TEXAS (DISTRICTS 9 & 7-B) SUCCESSFUL WILDCATS

Coleman County: Robertson, Rhodes & Camden 1 Jones estate "B," H. Haddock Sur. 118, 3½ mi. SE Novice, TD 3,289 ft., elev. 2,130 ft., pay 3,274 ft., flowed 252 bbl. 43°-gravity oil a day, ¼-in. choke, GOR 300 cu. ft., CP 280 psi., TP 60 psi.

Jones County: R-H-K Drilling Co., Ltd., 1 Herring & Largent, DeWitt CSL, League 149, 5 mi. N Merkel, TD 4,643 ft., elev. 1,791 ft., Strawn 4,556 ft., pay 4,582 ft., flowed 255.9 bbl. 42°-gravity oil a day, ¾-in. choke, GOR 800 cu. ft., CP 250 psi., TP 75 psi.

NORTH CENTRAL TEXAS (DISTRICTS 9 & 7-B) WILDCAT FAILURES

Archer County: Milton Fish 1 Baggett Lease, C. W. Dugan Sur., A-1058, 1 mi. W. Archer City, dry, TD 1,370 ft., sand with oil show 1,308-10 ft.

Neeld & Hood 1 S. J. Moss, Blk. 2479, TE&L Sur., 4 mi. N Megargel, dry, TD 2,217 ft.

Neeld & Hood 1 J. R. Parkey, SPRR Sur., A-419, 1½ mi. SW Holliday, dry, TD 1,764 ft.

Neeld & Hood 1 J. A. Young, Blk. 2426, TE&L Sur., 2 mi. SW Megargel, dry, TD 1,483 ft.

Reno Oil Co. 1 Netherton "A," Sec. 1, SPRR Sur., A-411, 8½ mi. SW Holliday, dry, TD 5,385 ft., lime 5,249 ft .

Baylor County: J. J. Lynn 1 Robertson, Robertson CSL, A-280, 12 mi. E Seymour, dry, TD 5,609 ft., elev. 1,233 ft., lime 5,431-83 ft.

Clay County: L. T. Burns 1 W. I. Howard, Blk. 2, Halsell Subd. 1, ¾ mi. SE Halsell, dry, TD 5,903 ft.

C. Y. Gorman 1 R. B. Stine, Parker CSL, A-374, 1½ mi. S Petrolia, dry, TD 1,822 ft.

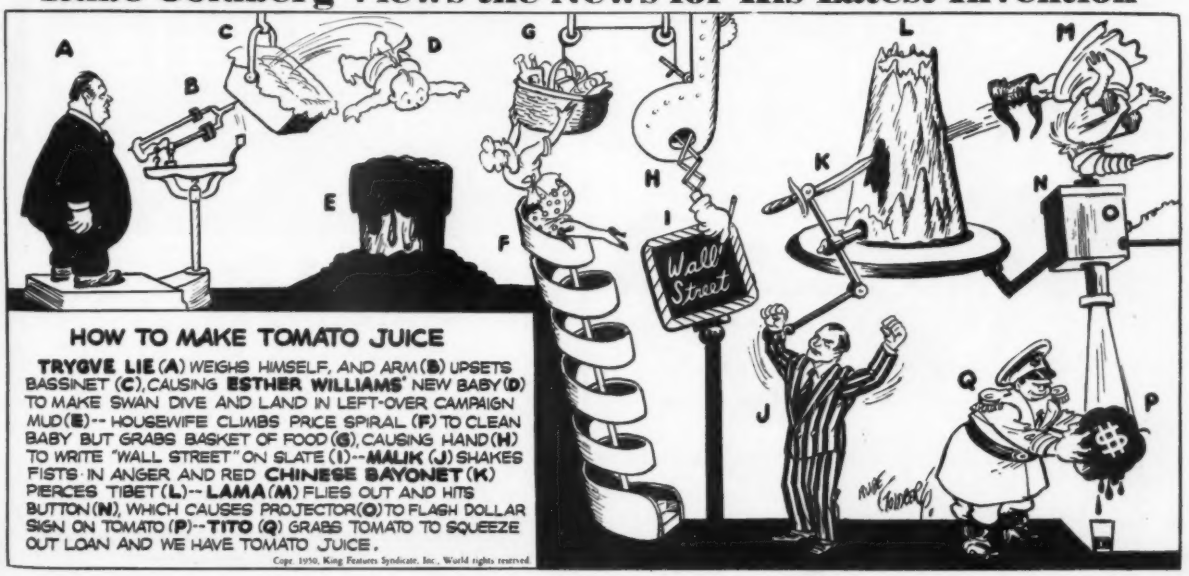
W. H. Metzner 1 R. B. Stine, Parker CSL A-354, 2½ mi. S Petrolia, dry, TD 1,902 ft.

Republic Natural Gas Co. 1 R. E. Speegle, C. Thompson Sur., A-444, 4 mi. NW Joy, dry, TD 4,720 ft.

Frank Wood 1 B. R. Stine, Parker CSL, ½ mi. S Petrolia, dry, TD 1,960 ft., conglomerate 1,771-83 ft.

Coleman County: H. H. Hamilton 1 J. A. Baucom, Daniel A. Murdock Sur. 738, 2 mi. SE Coleman, dry, TD 2,327 ft., elev. 1,726 ft., lime 2,306 ft.

Rube Goldberg Views the News for His Latest Invention



HOW TO MAKE TOMATO JUICE

TRYGVE LIE (A) WEIGHS HIMSELF, AND ARM (B) UPSETS BASSINET (C), CAUSING **ESTHER WILLIAMS'** NEW BABY (D) TO MAKE SWAN DIVE AND LAND IN LEFT-OVER CAMPAIGN MUD (E) -- HOUSEWIFE CLIMBS PRICE SPIRAL (F) TO CLEAN BABY BUT GRABS BASKET OF FOOD (G), CAUSING HAND (H) TO WRITE "WALL STREET" ON SLATE (I) -- **MALIK** (J) SHAKES FISTS IN ANGER AND RED **CHINESE BAYONET** (K) PIERCES TIBET (L) -- **LAMA** (M) FLIES OUT AND HITS BUTTON (N), WHICH CAUSES PROJECTOR (O) TO FLASH DOLLAR SIGN ON TOMATO (P) -- **TITO** (Q) GRABS TOMATO TO SQUEEZE OUT LOAN AND WE HAVE TOMATO JUICE.

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Comanche County: Frank Wood 1 Roy Mitchell, Sec. 11, League 1, Lampasas CSL, 6 mi. SE Sipe Springs, dry, TD 2,965 ft., elev. 1,436 ft., Barnett 2,830 ft., Ellenburger 2,935 ft.

Eastland County: Primo Oil Co. 1 Irven Pippen, Sec. 3166, TE&L Sur., 2 mi. NW Dothan, dry, TD 4,073 ft., elev. 1,521 ft., Gunsight 585 ft., Ranger 1,125 ft., Palo Pinto 1,630 ft., upper Capps 1,920 ft., lower Capps 2,230 ft., Caddo 3,278 ft., Marble Falls 3,545 ft., Lake sand 3,568 ft., Barnett 3,865 ft., Ellenburger 3,999 ft.

Haskell County: T. D. Humphrey 2 H. M. Rike, Sec. 61, R. G. Cummins Sur., 7 mi. NE Haskell, dry, TD 2,572 ft.

Jones County: Ohio Oil Co. 1 A. N. Shaheen "A," 53-15-T&P, 4½ mi. NE Hawley, dry, TD 2,343 ft., elev. 1,650 ft., Dothan 1,503 ft., Flippen 1,892 ft., King sand 2,166 ft., Swastika 2,237 ft.

Oxford Drilling Co. 1 J. L. Culberson "A," Sec. 157, BBB&C Sur., 7 mi. NE Hamlin, dry, TD 6,002 ft., elev. 1,732 ft., Gunsight 3,371 ft., Strawn 5,238 ft., Caddo 5,748 ft.

Primo Oil Co. 1 A. H. Lundgren, Sec. 174, BBB&C Sur., 4½ mi. E Avoca, dry, TD 2,212 ft.

Montague County: Konrad Sztykgold 1 J. H. Fields, T. King Sur., A-412, 2½ mi. SE St. Jo, dry, TD 6,540 ft.

Nolan County: National Associated Petroleum Co. 1 Duke Wilson, 197-64-H&TC, 8 mi. NE Blackwell, dry, TD 6,150 ft., elev. 2,334 ft., Flippen 3,430 ft., Canyon reef 4,345 ft., Fry sand 5,165 ft., Capps 5,293 ft., Gardner 5,582 ft., Caddo 5,778 ft., Ellenburger 5,945 ft.

Shackelford County: A. R. Dillard 1 Walker-Buckler Trust "A," J. Shirley Sur., 16 mi. NE Albany, dry, TD 617 ft.

Taylor County: Columbian Fuel Corp. 1 Elm Cattle Co., 276-64-H&TC, 6 mi. N Shep, dry, TD 6,130 ft., elev. 2,469 ft., Reef 4,334 ft., Strawn lime 5,326 ft., Caddo 5,838 ft., Marble Falls 5,930 ft., Mississippian 6,000 ft., Ellenburger 6,024 ft.

Lester & Duffield, Inc., 1 A. A. Story, J. McSherry Sur. 129, 1 mi. SW Tye, dry, TD 2,805 ft., elev. 1,818 ft., Flippen 2,332 ft., upper Hope 2,470 ft.

Throckmorton County: Emanon Drilling Co. 1 J. S. Gilbert, Sec. 926, TE&L Sur., 6 mi. SE Throckmorton, dry, TD 1,598 ft.

Wilbarger County: Frank Wood 2 W. T. Waggoner "T," 51-14-H&TC, 8 mi. S Vernon, dry, TD 2,086 ft.

Young County: C. G. Watson 2 C. G. Robinson, TE&L Sur. 1656, 3 mi. W Murray, dry, TD 592 ft., lime with wet gas 389 ft.

Michigan

Big Gasser Increases Interest in Cedar Creek

MOUNT PLEASANT.—The third and best Berea gas well completed to date in Cedar Creek field, Muskegon County, was added this week by Charles Hoffman at the 1 Gritzner Estate, SE NE SE 18-11n-15w, Cedar Creek Township. The new well was bottomed in the Berea at 1,135 ft. and was gaged at 4,100,000 cu. ft. of gas a day. Top of objective sand was logged at 1,125 ft. Pay showed from 1 ft. in the section to the total depth.

The first gas well, and also the discovery, was drilled about a mile southwest of this newest producer, in the NW NW SE 19-11n-15w. This gasser was gaged at 750,000 cu. ft. of gas a day. The second well was drilled about ½ mile northeast of the discovery, in the SE NE NE 19-11n-15w, and was rated at 2,150,000 cu. ft. daily. With this most recent move further north, and with an encouraging increase in gas, it is expected that a speeded up drilling program may be outlined for the Cedar Creek field. Gas from this area will be sold to an industrial market in the Muskegon industrial center.

P. K. Degenther announced two direct 10-acre offset starts to his 1 State-Heath, SE SE SW 22-3n-14w, new Traverse zone oil discovery, Heath Township, Allegan County. Cable tool drilling equipment was being moved to the SW SE SW 22-3n-14w, the west offset, and the east offset, SW SW SE 22-3n-14w, had been staked. Production tests at this most recent Heath Township oil discovery were being continued this week. Well was reported to have flowed 100 bbl. of net oil in 12 hours on last reported gage after acid treatment with 1,000 gal. Top of Traverse lime was logged at 1,424 ft. and hole was bottomed out at 1,438 ft. after pays showed at 1,426-28 and 1,435-38 ft. Hole carried about 80 ft. of free oil natural over a 3-day filling period.

MICHIGAN WILDCAT FAILURES

Allegan County, Hopkins Township: The Daily Crude Oil Co. 1 Miller, SE SE SW 28-3n-12w, Traverse 1,7111 ft., dry, TD 1,741 ft.

Clare County, Sheridan Township: Union Development Co. 1 Roger, NW SE NW 9-17n-3w, dry, TD 1,590 ft.

Isabella County, Fremont Township: Merrill Drilling Co. 1 Wyant, SW NW SE 5-13n-5w, Dundee 3,666 ft., dry, TD 3,700 ft.

Kalamazoo County, Alamo Township: Ford Oil Co. 3 Kokmeyer, Jr., NW SW SW 31-1s-12w, Traverse 1,275 ft., dry, TD 1,278 ft.

Ford Oil Co. 1 Magierka, SE SE NW 31-1s-12w, Traverse 1,282 ft., dry, TD 1,284 ft.

Kent County, Tyrone Township: H. E. Walton 1 County of Kent, SE SE SW 11-10n-12w, Traverse 2,338 ft., dry, TD 2,357 ft.

Mecosta County, Mecosta Township: Louis

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Rose 1 Huntey, SE SE NW 26-14n-10w, dry, TD 1,154 ft.

Ottawa County, Crockery Township: Fisher-McCall Oil & Gas, Inc. 1 Post, NE NW SE 23-8n-15w, Traverse 1,755 ft., dry, TD 1,908 ft.

Oklahoma

Oil Production Tested In Doyle Area Wildcat

BAY PETROLEUM CORP. appears to have a good oil discovery in its 1 Payne, SW SW SW 1-1n-5w, a wildcat located northeast of the Doyle pool in northeastern Stephens County. In a drill-stem test in Pennsylvanian sand at 6,638-86 ft., with tool open 100 minutes, the well showed gas within 4 minutes and oil within 88 minutes. Oil flow at the end was estimated at the rate of 15 bbl. per hour. Recovery in the pipe breakdown was 945 ft. of clean oil.

With hole deepened to 6,817 ft. in the section, and testing below 6,723 ft., the well flowed at the rate of 50 bbl. of oil per hour, oil being at the surface within 15 minutes after the tool was opened. Recovery at the end of the second test was 1,020 ft. of oil. Gravity of the oil was 40° A.P.I. Hole is being carried to the Springer sand, expected around 7,500 ft.

Moving steadily northward for a possible tie-in with the advancing southeast extension area of the Velma pool, development at the north end of the Milroy pool, Stephens County, added another good well with the completion by Stanolind Oil & Gas Co. of its 1 Truitt, NW NW NW 12-2s-4w. With casing perforated in the Pennsylvanian pay at 5,250-95 ft. and 5,305-50 ft., the well flowed 430 bbl. of 38° oil in 24 hours through 12/64-in. choke.

Two miles southeast of production at the south end of the Velma pool, Stanolind Oil & Gas Co. got 40 ft. of slightly oil-cut mud in a 3-hour drill-stem test of showings encountered in a shallow sand at 2,498-2,521 ft. in its 1 Dorrance, SW NE NE 19-2s-4w. Hole is being deepened to its 5,000-ft. objective.

After passing up promising oil and gas showings in Bromide sand, topped at 1,509 ft., Tide Water Associated Oil Co. 1 Myers, NE NE NW 10-4n-11w, 4½ miles southeast of Apache in northern Comanche County, has encountered additional potential gas production in a deeper zone at 2,232-71 ft. In a drill-stem test of this zone, gas was at the surface within 1 minute after the tester was opened and flowed at an estimated rate of 1,500,000 cu. ft. per day through ⅛-in. top and ½-in. bottom chokes. Bottom-hole flowing pressure ranged from 280 to 332 psi. Pressure built up to 1,060 psi. within 15 minutes when the well was shut in. Hole is being deepened.

In Garvin County, production on the west side of the Southwest Mayesville pool virtually has been linked with that in the New Hope extension area by the completion by Anderson-Prichard Oil Corp. of its 1 Christian-Morris, NE NW NW 35-4n-3w. Casing was perforated in two zones, one at 6,965-77 ft. and the other at 6,851-75 ft. In the first 9 hours, the well flowed 327 bbl. of fluid, mostly oil. Flow was through 1-in. choke the first 2 hours and ½-in. choke for 7 hours. Total depth is 7,020 ft.

Mid-Continent Petroleum Corp. has extended the Scott gas pool in Okfuskee County nearly a mile to the southeast at its 1 Scott, NW SE NE 29-10n-10e, completed as an exceptionally good gas producer in Hunton lime, opposite which casing was perforated at 3,870-90 ft. After being acidized, the well flowed at the rate of 41,700,000 cu. ft. of gas per day. Hole had been drilled to 4,254 ft. in the Wilcox.

OKLAHOMA SUCCESSFUL WILDCAT

Okfuskee County: Kingery & Petterson 1 Seran, SE SW NW 12-12n-8e, elev. 830 ft., ⅞ mi. SE Valley Grove, pumped 72 bbl. 22.6°-gravity oil per day from

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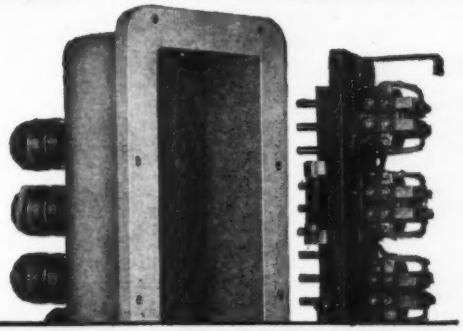

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OKLAHOMA WILDCAT FAILURES

Alfalfa County: H. L. Hurst 1 Shields, C SE SE 25-26n-9w, elev. 1,176 ft., dry, TD 6,417 ft., Tonkawa 4,281 ft., Layton 4,730 ft., Hogshooter 4,845 ft., Big lime 5,095 ft., Mississippian 5,530 ft., Kinderhook 6,015 ft., Woodford 6,055 ft., Sylvan 6,140 ft., Viola 6,182 ft., Wilcox 6,275 ft., second Wilcox 6,350 ft.

Carter County: E. Dunlap, Jr., and W. Gant 1 Overstreet, SE SE NW 36-5s-1w, elev. 847 ft. DF, dry, TD 6,340 ft., Deese 4,571 ft., sand 5,670 ft., Hunton 5,906 ft., Sylvan 6,307 ft.

Cotton County: Bridwell Oil 2 Halsey, NW SE NW 30-3s-10w, dry, TD 1,731 ft., broken sand 1,405 ft.

J. W. Baldwin 1 Thurman Graham, SW SW SE 33-4s-10w, dry, TD 2,000 ft., conglomerate 1,010 ft., Megargel 1,840 ft.

Jefferson County: Sun Drilling 1 Kirby, NW SE NW 17-8s-6w, elev. 791 ft., dry, TD 6,017 ft., Cisco-Hoxbar unconformity 2,132 ft., base Palo Pinto group 2,486 ft., middle Hoxbar sand 2,932 ft., KMA 3,060 ft., Confederate 3,802 ft., basal oolitic 4,350 ft., oolitic lime 4,482 ft., Deese 4,512 ft., Bend 5,368 ft., Arbuckle 5,907 ft.

Kay County: L. G. Squires and Sam Tennant 1 Otto, NW NW SW 23-27n-2e, est. elev. 1,100 ft., dry, TD 3,716 ft., Pawhuska 1,500 ft., upper Hoover 1,600 ft., lower Hoover 1,760 ft., Oread 1,860 ft., Layton 2,770 ft., Checkerboard 3,090 ft., lime 3,260 ft., Cherokee shale 3,415 ft., Mississippi lime 3,620 ft.

Lincoln County: Sinclair 1 Threatt, NE NE SW 18-14n-2e, elev. 977 ft., dry, TD 5,205 ft., Layton 3,682 ft., Checkerboard 3,963 ft., Oswego 4,517 ft., Prue 4,634 ft., Verdigris 4,698 ft., lime 4,849 ft., Red Fork 4,853 ft., Bartlesville 4,946 ft., Woodford 5,094 ft., Hunton 5,154 ft., Sylvan 5,191 ft.

Scat Drilling 1 Von Deylen, NE SW SE 7-16n-6e, elev. 901 ft., dry, TD 3,502 ft., Hogshooter 2,032 ft., Layton 2,088 ft., Checkerboard 2,336 ft., conglomerate 2,382 ft., no Big lime, Oswego 2,976 ft., Prue 3,048 ft., Verdigris 3,109 ft., no Skinner, lime 3,281 ft., no Red Fork, Inola 3,409 ft., Bartlesville 3,411 ft.

McClain County: Big Chief Drilling and Russell Maguire 1 Hinkle, C SE NW 33-5n-3w, elev. 1,013 ft., dry, TD 7,634 ft., first Deese 7,112 ft., second Deese 7,156 ft., third Deese 7,372 ft., fourth Deese 7,503 ft., Woodford 7,622 ft.

Okfuskee County: Zephyr Petroleum and Alpha Petroleum 1 Whitten, NE NE SE 32-12n-8e, dry, TD 3,771 ft., Union Valley 3,755 ft., Cromwell 3,768 ft., lime 3,256 ft., Booch 3,515 ft.

Osage County: Oliphant 1 Osage, SW SE NW 8-25n-3e, elev. 1,111 ft., dry, TD 3,859 ft., upper Layton 2,805 ft., lower Layton 3,004 ft., Burbank 3,666 ft., Mississippi chat 3,808 ft., Mississippi lime 3,823 ft.

Pontotoc County: W. H. Pine 1 Kilcrease, SW NW NE 17-3n-7e, elev. 844 ft., dry, TD 2,147 ft., Mayes 1,250 ft., Woodford 1,295 ft., Hunton 1,384 ft., Sylvan 1,783 ft., Viola 1,864 ft.

Seminole County: Ryan Oil 1 Norvell, NE SE SE 24-10n-7e, elev. 945 ft., dry, TD 4,435 ft., lower Calvin 2,060 ft., Skinner 2,440 ft., Earlsboro 2,779 ft., Hunton 4,132 ft., Sylvan 4,207 ft., Viola 4,304 ft., Wilcox 4,361 ft., second Wilcox 4,402 ft.

Stephens County: J. E. Crosbie, Inc., 1 Ethel May, NW NW NE 9-2s-7w, elev. 1,035 ft., dry, TD 4,670 ft., Loco lime 2,907 ft., Nichols (?) 4,028 ft., Yates (?) 4,114 ft., Simpson detrital 4,228 ft.

Wegener 1 Steelman, NW SW NE 23-1n-7w, elev. 1,225 ft. DF, dry, TD 7,007 ft., base Pontotoc-Cisco 5,070 ft., sand 6,005 ft., 6,844 ft., 6,880 ft., and 6,948 ft.

Tillman County: Kadane & Sons 1 Fuqua "A," SE SE NW 11-4s-16w, dry, TD 3,720 ft., Canyon 3,121 ft.

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Canadian Fields

Another Extension For Stettler D-2

CALGARY—Canadian Gulf Oil Co., discoverer of the Stettler Devonian oil field, chalked up a 1-mile northeast extension to the company's previously established producing limits in that field. The new extension success flowed natural gas and oil from D2 zone of Devonian during two drill-stem tests recently run. The well, Gulf-Ernest Leschert 5, in LSD 5, 14-38-20w4, is located 1 mile northeast of Gulf-Ellis 11 producer and ¾ mile north-northeast of Ellis 9 driller. First D2 drill-stem test at the Leschert venture was run of the interval 5,224-32 ft., with natural gas flowing to the surface in 6 minutes and oil in 65 minutes. Estimated flow rate was 30 bbl. hourly. Second test, from 5,232-42 ft., gave a gas flow in 4 minutes and oil in 68 minutes, with oil flow rate estimated at 45 bbl. hourly. There was no water present when pipe was pulled and crew is coring ahead below 5,242 ft.

Alberta's most recent natural gas discovery well ran another drill-stem test in a Bow Island sand horizon and again received a sizable flow of gas. The discovery, Albercan-Sun-Sibbald 1, in LSD 15, 5-28-2w4, is about 160 miles east-northeast of Calgary and 10 miles from the Saskatchewan border. Latest drill-stem test was run in the Bow Island interval 2,450-57 ft. During the 20-minute test natural gas flow rate was measured at 4,135,000 cu. ft. daily. Crew is continuing to core and test at 5-ft. intervals. First drill-stem test, from 2,439-50 ft., gave a natural gas flow exceeding 5,000,000 cu. ft daily, with no fluid recovery.

Oxford Development, Ltd., private Alberta firm, has found some natural gas encouragement and a slight showing of oil and water in the Lower Cretaceous at its wildcat in the new Sarepta area of central Alberta. Crew is now heading down for Devonian objectives. The well, Oxford-Sarepta 1, in LSD 14, 22-49-23w4, ran a drill-stem test of interval 4,118-25 ft. and received a maximum natural gas flow rate of 458,000 cu. ft. daily, plus a pipe recovery consisting of 40 ft. of oil and 500 ft. of water. Drilling is proceeding at 4,297 ft., in search of the Devonian objectives.

The British American-Bocock-Withers 1 at Campbell may be a little too high on structure for commercial oil production, but drill-stem tests in recent days showing large volumes of natural gas with crude oil and water in basal section offer considerable encouragement for downdip locations. The well, in LSD 3, 33-54-25w4, is about ¾ mile northwest of Redwater Leaseholds Group's Campbell oil wells, producing from Lower Cretaceous sands. It will continue on to top of the Devonian before deciding on completion procedure. Current depth is 3,829 ft., drilling.

Summary of drill-stem test results in Lower Cretaceous at British American-Bocock follows: Interval 3,703-23 ft., gas flow rate 3,816,000 cu. ft. daily, pipe recovery 180 ft. of oil and gas-cut mud; interval 3,726-37 ft., gas flow rate 7,475,000 cu. ft. daily, pipe recovery 15 ft. of mud; interval 3,737-44 ft., gas flow rate 4,220,000 cu. ft. daily, pipe recovery 60 ft. of 33°-gravity crude oil; interval 3,744-52 ft., small gas blow rate 15,000 cu. ft daily, pipe recovery in 1 hour was 1,300 ft. of crude oil and 1,470 ft. of salt water.

Illinois-Ind.-Ky.

New Oil Pool Indicated In Vanderburgh County

DISCOVERY of another new pool, located in the St. Phillips area, about 5 miles west of Evansville, in the southwestern corner of Vanderburgh County, Indiana, appears to have been made by Skiles Oil Corp. at its 1 Shrode, NW SW SW 18-6s-11w. The well, ¾ to 1 mile west of production of the Belknap pool, has good saturation in the Cypress sand at 2,354-65 ft. Bottom of the hole still is in sand. A drill-stem test of the above interval got a substantial showing of gas and had 660 ft. of clean oil and 120 ft. of mud-cut oil in the pipe after tool had been open 60 minutes. Bottom-hole pressure was 600 psi. Casing is being run. Location is only 330 ft. east of the Posey County line.

McMahon & Ellis have completed their 1 Paul Boggess, NW SE SW SW 14-1-29, 2 miles east of Greenville, Muhlenberg County, Kentucky, to open the Greenville East pool. The well pumped 15 bbl. of oil per day following a 40-qt. shot in the Aux Vases zone at 1,675-84 ft. Total depth is 1,686 ft. with hole open below 1,670 ft.

The new pool opened last month by Graham Development Co. in the area a mile northwest of Monroe City, Knox County, Indiana, is getting additional confirmation. I. F. McCandlish 1 Helderman, Militia Donation 39-2n-9w, northeast offset to the discovery well, swabbed 300 bbl. of oil daily from highly saturated Aux Vases lime, the producing zone of the discovery well. Saturation is at 1,502-10 ft. This pool is proving one of Indiana's most promising discoveries in recent months. Four additional wells are drilling in the area.

A new Tar Springs sand pool has been opened in the southwest corner of Posey County, Indiana, with the completion by William Schuller of his 1 Keck, NE SE NW 11-6s-14w. The well pumped 8 bbl. of net oil daily with pay at 2,209-16 ft. Pay zone was shot with 50 qt. Total depth is 2,228 ft. with hole open below 2,209 ft. Location is 1¼ miles east of Savah, which name has been applied to the pool. It is about 1½ miles from nearest production in that area.

ILLINOIS SUCCESSFUL WILDCAT

Gallatin County: Coy Oil Co. 1 Drone, NW SE NW 31-8s-10e, IP 38 bbl., Aux Vases lime 2,727-32 ft., TD 2,754 ft. (opens new pay Inman pool.)

ILLINOIS WILDCAT FAILURES

Clinton County: Ash Drilling Co. 1 Kampwerth, SE NW SW 24-3n-4w, dry, TD 1,013 ft.

J. F. Dunnell 1 Handley, NW NE SE 8-2n-2w, dry, TD 1,301 ft.

Coles County: R. H. Troop et al., 1 Van Tyle, NW NW SE 7-13n-14w, dry, TD 400 ft.

Edwards County: Spear Oil Co. et al., 1 McDowell, NW SE SW 18-1n-14w, dry, TD 3,261 ft.

Fayette County: T. S. Doran et al., 1 Mitchell, NW NE NW 1-5n-1w, dry, TD 1,665 ft.

Hamilton County: George & Wrather 1 Rogers, NW SW SE 11-7s-6e, dry, TD 3,380 ft.

Dale Hopkins - Flannigan-Porter, SW SE SE 7-4s-7e, dry, TD 3,478 ft.

Skiles Oil Corp. 1 Crow, SE SW NE 31-6s-5e, dry, TD 3,419 ft.

Jasper County: Davis & Johnson 1 Milliman, NW NW NE 11-5n-10e, dry, TD 2,935 ft.

Supp et al., 1 Cox, NE SE NE 7-8n-14w, dry, TD 635 ft.

Jefferson County: Bell Brothers 1 Youngblood, SW SE NE 24-1s-4e, dry, TD 3,081 ft.

Macoupin County: F. B. Schlenck 1 Terrands, SW NE SE 35-7n-6w, dry, TD 635 ft.

Marion County: W. C. Willman 1 Seid Community, NE NW SW 13-2n-1e, dry, TD 2,236 ft.

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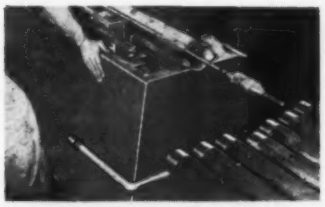
The Tube-Kote plant-controlled process of applying "TK-2," thermo-setting (baked on) plastics assures a tough, extremely durable protective coating on the inner surfaces of oil field tubular goods. Prevents corrosion from the inside, ends problems of paraffin deposition, eliminates many costly "shut downs" due to pipe failures.



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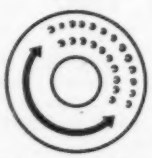

Reversible Seat Gauge Cocks

Two adjustment holes on Gauge Cock handle bracket allow two rows of impressions on seat disc. When one side is used up disc may be reversed. In this way entire surface of both sides of seat discs of Inferno Gauge Cocks can be utilized. The saving is obvious. Write for Bulletin 18-C. Sold through supply stores.

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Monroe County: Hecker Oil Co. 1 Cowell, NW SW NE 28-3s-8w, dry, TD 805 ft.
Peoria County: R. Natzke 1 Natzke, NE NW NW 34-10n-6e, 4th P.M., dry, TD 335 ft.
Pope County: L. F. Wilson 1 Akerson, NE SE SE 32-13s-5e, dry, TD 340 ft.
Richland County: Skiles Oil Corp. 1 Heath, SW NW SW 23-3n-14w, dry, TD 3,161 ft.
P. Faulk 1 Mason, NE NW SE 17-2n-9e, dry, TD 3,200 ft.
Wayne County: Skiles Oil Corp. 1 Bennett, NW SE NW 18-1n-5e, dry, TD 2,967 ft.
P. Faulk 1 Lawrence, NE NE SW 3-3s-7e, dry, TD 3,294 ft.
White County: V. R. Gallagher 1 Westergard, SW SE NW 29-6s-11e, dry, TD 2,976 ft.

INDIANA SUCCESSFUL WILDCATS

Marshall County: C. W. Kendall 1 Nelson Seetenright, NW SE SE 11-34n-2e, IP 1,250,000 cu. ft. of gas, Niagara sand 370-72 ft., TD 372 ft. (opens new gas pool).
Posey County: William Schuller 1 Lena Keck, NE SE NW 11-6s-14w, IP 8 bbl., Tar Springs 2,209-16 ft., TD 2,228 ft. (opens Savah pool).

INDIANA WILDCAT FAILURES

Daviess County: J. H. Lawrence 1 Kavanaugh, SW SW SW 7-2n-5w, dry, TD 860 ft.
Sunlight Coal Co. 1 Wittmer, NW NE NE 2-3n-6w, dry, TD 755 ft.
Charles Clemens 1 Alison Heirs, NW SE NW 35-2n-7w, dry, TD 1,080 ft.
Gibson County: Shulman Brothers 1 McDonald, NW SW NW 32-3s-9w, dry, TD 2,063 ft.
Posey County: Howard D. Atha 1 White Orphanage, SE SW SE 2-6s-14w, dry, TD 3,009 ft.
Vanderburgh County: G. L. Reasor 1 Fisher, SW SE SE 35-4s-11w, dry, TD 2,521 ft.

WESTERN KENTUCKY SUCCESSFUL WILDCATS

Muhlenberg County: McMahon & Ellis 1 Boggess, NW SE SW SW 14-I-29, IP 15 bbl., Aux Vases 1,675-84 ft., TD 1,686 ft. (opens Greenville East pool).
Webster County: Iley B. Browning, Jr., and W. S. Browning 1 Crowley, NE NW NW NW 18-N-23, IP 54 bbl., Tar Springs 1,889-99 ft., TD 1,911 ft. (extension Poole district).

WESTERN KENTUCKY WILDCAT FAILURES

Breckinridge County: James C. Ellis 1 Weedman, S½ NW NE NW 12-N-36, dry, TD 1,880 ft.
Daviess County: Ryan Oil Co. 1 Mitchell, W½ NE NE SE 7-N-29, dry, TD 1,800 ft.

EASTERN KENTUCKY

ASHLAND.—Kentucky Ohio Gas Co. has completed its third well on William Oliver tract located on Oliver's Branch of Newcombe Creek in eastern Elliott County. Weir sand topped at 955 ft. paid from 993 to 1,021 ft. with initial production of 5 bbl. daily. Pay was shot with 130 qt. of nitroglycerin.

In Big Sandy gas field of eastern Kentucky, Kentucky West Virginia Gas Co. has completed the following producers: 958 John E. Taylor, Big Branch of Brushy Fork in Pike County, 337,000 cu. ft. of gas daily from Devonian black shale at total depth 3,222 ft.; 952 Jack L. Hatcher et al, Caney Creek in Pike County, 539,000 cu. ft. of gas daily from Big lime (Mississippi) and Devonian black shale at total depth of 4,244 ft.; 5939 Richard Roberts, Caney Creek, Pike County, 216,000 cu. ft. gas daily from Salt sand and Devonian shale at total depth of 4,056 ft.

Mississippi

Stone County Well Coring Below 18,764 Ft.

JACKSON.—George Vasen 1 Tung Oil Corp., Stone County wildcat, is coring below 18,764 ft., making it the second deepest well in the world. It is reported that at present depth, cores include dark black shale described as "oily" in appearance, indicating that the Smackover formation has been passed and new formations are penetrated.

In southeastern Perry County, Hunt & Whitaker Oil Co. 1 U.S.D.A., 18-1n-11w, wildcat, started coring at 8,907 ft. on first drilling break in the lower Tuscaloosa. Two cores were cut at 8,907-20 ft. with no show. At last report, drilling was continuing below 8,994 ft. looking for the "massive" sand.

Approximately 7 miles northwest of Canton, Madison County, Continental Oil Co. 1 John R. Cameron et al, SE SW 36-10n-1e, cut a core at 7,917-65 ft. with recovery being 48 ft. of salt water sand with a few streaks of gravel. Operator drilled ahead and picked up fluorescence and slight show of gas in cuttings at 8,122-31 ft. Core was then cut at 8,131-80 ft. with recovery being 43 ft. of salt water sand with a few thin streaks of shale. This well has encountered several shows, but none are thought to be commercial.

In Adams County, Mississippi, between Carthage Point and Glen Aubin fields, R. J. Bartlett-Barnett Serio 1 George W. Armstrong, 37-6n-3w, possible new Wilcox discovery, is still in the process of installing pump. Final completion will not be made until pumping test is made.

LaGrange field-South, Adams County, has been extended 2,200 ft. eastward with completion of Kemp Drilling Co. 1 E. B. Ogden, 42-6n-2w, which flowed 107 bbl. of oil per day through 12/64-in. choke. Gravity of the oil was 44°. Production is through perforations at 6,443-45 ft.

Appalachian Field

New Maryland Area Gets More Starts

PITTSBURGH.—In Garrett County, Maryland, operations have been started at four wells in the Mountain Lake Park area, Oakland Quadrangle: Columbian Carbon Co. 1 Joni J. Miller, rigging up; Eberly & Snee 1 Camp Meeting Holiness Association, building rig and 1 fee, clearing location; and George L. Yaste 1 Grimes, hauling rig. Columbian Carbon Co. 1 Oren T. Graser is drilling at 1,830 ft. and Eberly & Snee 1 E. O. Donald is spudding.

In Portland district, Preston County, West Virginia, Eberly & Snee have located 1 S. E. Calvert, elevation 2,188 ft. It is in the Terra Alta section on the Kingwood Quadrangle, 5.7 miles south of Lat. 39° 30′ and 0.5 mile west of Long. 79° 35′. In the Limestone Hill area, Steele district, Wood County, three wells have reported the top of the Corniferous lime: Columbian Carbon Co. 1-GW-1157 Earl Ryan et al, elevation 834 ft., Corniferous lime 4,880 ft., drilling at 4,966 ft.; Hope Natural Gas Co. 9468 Frank Gilmore, elevation 827 ft., Corniferous lime 4,857 ft., drilling at 4,895 ft. and 9471 Maggie Ludwig, elevation 728 ft., Corniferous lime 4,767 ft., drilling at 4,777 ft.

Fourteen new wells in West Virginia were reported during the past week: Ravenswood and Union districts, Jackson County; Elk district, Kanawha County; Harts Creek district, Lincoln County; Chapmanville and Tridelphia districts, Logan County; Kermit and Lee districts, Mingo County; Big Creek district, McDowell County; and Portland district, Preston County:

In North Central Pennsylvania five new locations were reported in Leidy Township, Clinton County: Pipe Line Construction Co. 1 State Lands, Tract 6, and 1 State Lands, Tract 7; Leidy Prospecting Co. 4

Calhoun Estate; C. E. Fralich et al 3 State Lands, Tract 4; and Keta Gas & Oil Co. 1 Andrew Carlson. No completions were reported in this section.

Four new locations in Southwest Pennsylvania were reported during the past week: Washington Township, Armstrong County; Washington Township, Indiana County; South Strabane Township, Washington County; and Allegheny Township, Westmoreland County.

Louisiana-Arkansas

Catahoula Parish Prospect To Test Wilcox Shows

SHREVEPORT.—Catahoula Parish appears to be in line for its second discovery this year at Hunt Oil Co. and Gulf Refining Co.'s wildcat south of South Larto Lake field. The well, 27 Louisiana Delta Hardwood Lumber Co., found shows in Wilcox at 5,895-5,903 ft. in side-wall samples. Total depth is 7,500 ft., with 5½-in. pay string set to 5,968 ft.

In Union County, Arkansas, J. L. Foster recovered oil in a rework project. The well, 1 Irby, NE SE 28-18s-17w, had 5½-in. casing set at 4,094 ft., and perforated at 4,010-14 ft. with 16 shots. The well flowed 400 bbl. of oil daily through ⅜-in. tubing choke. It was completed early this year as dry at 7,885 ft. At that time Schlumberger log reported the following tops: Arkadelphia 1,925 ft., Nacatoch 2,042 ft., base Annona 2,504 ft., James 3,609 ft., Travis Peak 4,030 ft., Cotton Valley 5,445 ft., Jones sand 7,668 ft., Smackover 7,755 ft., porosity 7,790 ft.

A Columbia County wildcat, Arkoma Oil Co. et al 1 Boyd, is drilling below 7,429 ft. On elevation of 352 ft., the test topped Cotton Valley at 5,615 ft. and Buckner at 7,305 ft.

In Boscoe field, Ouachita Parish, Louisiana, Petersen Drilling Co. 2 Breece logged six gas sands. The sands were encountered at the following intervals: 3,320-35 ft., 3,480-3,500 ft., 3,600-18 ft., 5,008-22 ft., 5,209-19 ft., and 5,440-50 ft. The well went to 5,511 ft. with 7-in. casing at 5,510 ft.

Three wells in Waskom field, Caddo Parish, received state potentials. Stanolind Oil & Gas Co. 1 Wise unit was good for 111 bbl. of oil per day; the same company's 1-D Mappler made 112 bbl. per day; Hilburn Drilling Co.'s 1 Scott pumped 400 bbl. per day. All wells produce from Mooringsport lime. In the same parish, Plymouth Oil Co. 5 Thigpen-Herold reported 5 bbl. of oil per day in Greenwood gas pool. Another state potential was established in East Haynesville field, Clairborne Parish, at Brooks Drilling Co.'s 1-A Winn, gaging 150 bbl. per day.

NORTH LOUISIANA WILDCAT FAILURES

Bossier Parish: R. P. Oden 1 fee, 3-18n-13w, dry, TD 5,755 ft., elev. 182 ft., Massive anhydrite 4,335-4,575 ft., Hill porosity 4,653 ft., Gloyd 4,815 ft., Pettit porosity 5,592 ft.

Grant Parish: Norman Germany and Glasscock Drilling Co. 1 R. L. Parish, 35-7n-1e, dry, TD 4,800 ft., elev. 171 ft., Wilcox 2,790 ft.

LaSalle Parish: J. S. Michael 1 Nebo Oil Co., 20-7n-3e, dry, TD 4,520 ft.

West Carroll Parish: Shelton Development Corp. 1 L. C. Shelton, 13-20n-8e, dry, TD 3,608 ft.

ARKANSAS WILDCAT FAILURES

Crittenden County: Patterson Bros. 1 Percy Magnesa, 25-8n-6e, dry, TD 3,215 ft.

Ouachita County: R. S. Allison Trust 1 Bergest, 29-13s-19w, dry, TD 4,314 ft., elev. 225 ft., Midway 586 ft., Lower Cretaceous 2,134 ft., Travis Peak 2,396 ft., Cotton Valley 3,096 ft., Buckner 4,110 ft., Smackover 4,302 ft.

Pipe-Line Construction

(Continued from page 377)

Trunkline Gas Supply Co.—1,775 miles, 10-26-in., planned, includes 740-mile, 26-in., Lake Charles, La., to Tuscola Station of Panhandle Eastern Pipe Line Co., and 1,035 miles, 10-24-in., Lake Charles, La., to McAllen, Tex., completion due October 1, 1952.

Trunkline Gas Supply Co.—176 miles, 26-in., under way, Darnell, La., to Longville, La.; Houston Contracting Co., contractor of Section A, main line. E. C. Norris, Olla, La., spreadman. W. H. Hayes, spreadman, De Ridder, La.

Trunkline Gas Co.—180 miles, 26-in., contracted, Darnell, La., to Senatobia, Miss.; Anderson Bros. Corp., contractor, Section B, main line.

Trunkline Gas Supply Co.—184 miles, 26-in., under way, Senatobia, Miss., to Paducah, Ky.; R. H. Fulton & Co., contractor of Section C, main line. Ed Veach, Memphis, Tenn., spreadman.

Trunkline Gas Co.—186 miles, 26-in., contracted, Joppa to Tuscola, Ill.; Mahoney Contracting Co., contractor of Section D, main line.

Trunkline Gas Co.—262 miles, 20-in., contracted, McAllen to Altair, Tex.; R. H. Fulton & Co., contractor of Section E and F, lateral lines.

Trunkline Gas Co.—217 miles, 24-in., contracted, Longville, La., to Altair, Tex.; Anderson Bros. Corp., contractor of Sections G and H, lateral line.

Trunkline Gas Supply Co.—71 miles, 20-16-10-in., contracted, Longville, La., south; Houston Contracting Co., contractor of Section I, lateral line.

United Gas Pipe Line Co.—51 miles, 12¾-in., proposed, Soso and Sherron fields, to near Meridian, Miss.

United Gas Pipe Line Co.—23 miles, 16-in., proposed, Mud Lake field, La., to near Port Arthur, Tex.

Working hub deep in mud, this Wisconsin Heavy-Duty Air-Cooled Engine pumps water to the mud pits on a drilling rig just west of Snyder, Texas . . . an important task and a wet one.

Wisconsin Engines work day in and day out under all conditions and all climates due in part, of course, to the easily serviced OUTSIDE magneto with impulse coupling for quick, any-weather starting . . . and also because of the foolproof any-climate air-cooling and tapered roller bearings at both ends of the shaft, taking up all thrust. Such features as these influence the preference for Wisconsin Engines among both users and oil equipment builders, who know that Wisconsin Engines add up to "Most H.P. Hours" on the job . . . lower operating and maintenance costs.

4-cycle, single-cylinder, 2-cylinder, and V-type 4-cylinder models, 3 to 30 hp.

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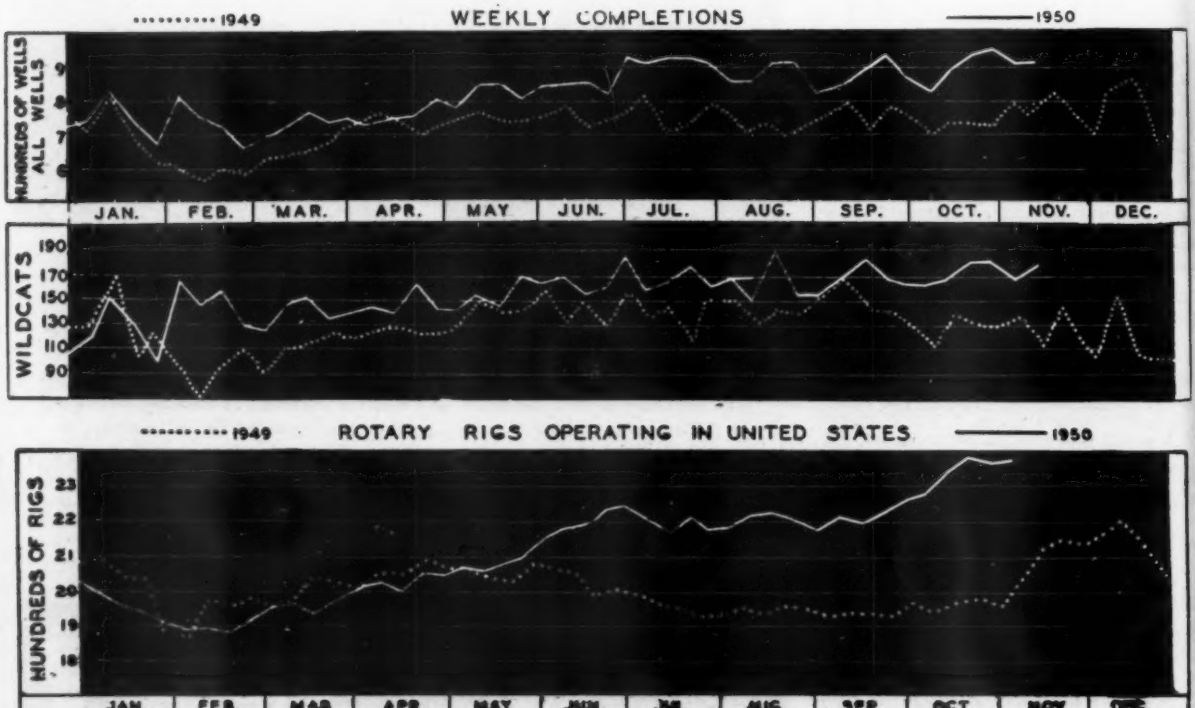
CURRENT STATISTICS

EXPLORATION

WEEKLY WELL COMPLETIONS . . . . WEEK ENDED NOVEMBER 11, 1950

	Total of all wells					Nov. 11		Wildcat completions and discoveries									
													Cumulative total, 1950				
	Comp.	Oil	Gas	Dry	Footage	1950	1949	Oil	Dist.	Gas	Dry	Total	Oil	Dist.	Gas	Dry	Total
New York	13	7	0	*6	18,928	600	841	0	0	0	0	0	0	0	0	0	0
Pennsylvania	27	11	4	†12	45,847	1,181	1,386	0	0	0	0	0	0	0	1	3	4
West Virginia	20	5	10	5	48,845	577	453	0	0	0	0	0	0	0	20	18	38
Ohio	31	13	8	10	52,210	903	952	0	0	0	1	1	2	0	2	15	19
Indiana	41	8	3	30	69,545	1,450	1,178	1	0	1	6	8	51	0	2	232	285
Kentucky	28	14	5	9	54,667	1,036	871	2	0	0	2	4	25	0	1	87	113
Illinois	69	25	0	44	155,284	2,465	2,265	1	0	0	21	22	50	0	2	530	582
Michigan	18	7	2	9	35,993	779	896	0	0	0	8	8	32	0	5	262	299
Kansas	87	51	6	‡30	279,279	3,378	2,850	1	0	0	11	12	96	0	11	561	668
Nebraska	6	4	0	2	24,098	112	30	0	0	0	1	1	6	0	4	49	59
Oklahoma	121	72	2	47	449,440	4,698	3,7.9	1	0	0	16	17	140	6	15	575	736
Texas	326	209	10	107	1,419,546	14,242	11,601	13	1	1	66	81	441	40	102	2,294	2,877
North Central (Dist. 7-B & 9)	107	62	0	‡45	301,382	4,319	3,861	2	0	0	27	29	192	2	29	896	1,119
West (Dist. 7-C & 8)	111	81	0	30	576,728	4,306	2,329	2	1	0	24	27	84	3	5	456	548
Panhandle (Dist. 10)	13	5	7	1	38,660	783	829	0	0	0	0	0	1	0	2	17	20
Eastern (Dist. 5, 6, & 6-P)	16	9	0	7	72,799	991	740	0	0	0	6	6	15	5	3	172	195
Gulf Coast (Dist. 2 & 3)	36	24	3	9	218,294	1,996	1,706	3	0	1	3	7	74	18	38	338	468
Southwest (Dist. 1 & 4)	43	28	0	15	211,683	1,842	1,636	6	0	0	6	12	75	12	25	415	527
Louisiana	48	24	3	21	340,719	2,123	2,040	1	0	0	8	9	45	16	6	192	259
Northern	19	8	3	8	62,720	1,139	1,222	0	0	0	4	4	11	3	2	93	109
Southern	29	16	0	13	277,999	984	818	1	0	0	4	5	34	13	4	99	150
Arkansas	5	1	0	§4	14,291	347	282	0	0	0	2	2	10	0	0	78	88
Mississippi	8	3	0	5	57,919	276	298	0	0	0	4	4	10	2	0	104	116
Southeastern States	2	1	0	1	16,897	52	43	0	0	0	1	1	1	0	1	28	30
Montana	0	0	0	0	0	214	213	0	0	0	0	0	1	0	0	35	36
Wyoming	15	8	0	7	53,301	514	509	0	0	0	1	1	21	0	1	76	98
Colorado-Utah	3	1	1	1	16,200	91	125	0	0	1	0	1	4	0	3	56	63
New Mexico	10	6	2	2	32,693	534	451	0	0	0	0	0	11	1	3	49	64
California	35	24	2	9	127,485	1,554	2,237	1	0	0	6	7	23	0	4	335	362
Miscellaneous	0	0	0	0	0	47	24	0	0	0	0	0	0	0	0	22	22
Total United States	913	494	58	361	3,313,187	37,174	33,274	21	1	3	154	179	969	65	183	5,601	6,818
Total previous week	910	510	43	357	3,321,087	....	....	19	0	2	147	168	948	64	180	5,447	6,639
Total November 11, 1949	752	413	61	278	2,713,997	....	....	12	0	2	103	117	817	74	168	4,834	5,893

Service wells included: *6, †11, ‡1, §2.



DAILY AVERAGE PRODUCTION FOR WEEK

	Nov. 11 crude oil	B. of M. Nov. demand	Nov. 4 crude oil
Alabama	2,400	1,600	2,400
Arkansas	82,800	88,000	82,650
California	952,700	950,000	940,600
Colorado	76,450	67,000	76,400
Eastern	66,600	65,000	66,500
Florida	1,875	1,400	1,475
Illinois	176,400	184,000	176,200
Indiana	31,000	31,000	29,900
Kansas	302,700	306,000	295,400
Kentucky	30,000	30,000	30,000
Louisiana	585,550	606,000	583,975
North Louisiana	117,550	.....	117,250
South Louisiana	468,000	.....	466,725
Michigan	40,800	47,000	40,700
Mississippi	104,600	110,000	99,250
Montana	22,400	24,000	22,400
Nebraska	5,100	5,000	5,100
New Mexico	130,925	150,000	131,300
Oklahoma	492,250	466,000	491,200
Texas	2,560,975	2,350,000	2,564,900
Dist. 1 (Southwest)	31,200	.....	31,125
Dist. 2 (Southwest)	148,725	.....	149,300
Dist. 4 (Southwest)	235,775	.....	234,700
Dist. 3 (Gulf Coast)	443,450	.....	446,625
Dist. 5 (Eastern)	42,850	.....	42,900
Dist. 6 (Eastern)	98,500	.....	99,825
East Texas field	291,000	.....	293,150
Dist. 7-C (West)	71,450	.....	71,175
Dist. 8 (West)	886,500	.....	879,650
Dist. 7-B (W. Central)	71,875	.....	74,800
Dist. 9 (N. Central)	149,650	.....	151,650
Dist. 10 (Panhandle)	90,000	.....	90,000
Utah	3,650	4,000	3,700
Wyoming	166,100	184,000	167,200
Total United States	*5,835,275	5,670,000	5,811,250
Change from previous week, up	24,025		
Canada	92,515	.....	104,090

Total U. S. production January 1-November 11 †1,690,521,875 bbl.
Same period last year (crude plus cond.)..... 1,596,826,810 bbl.

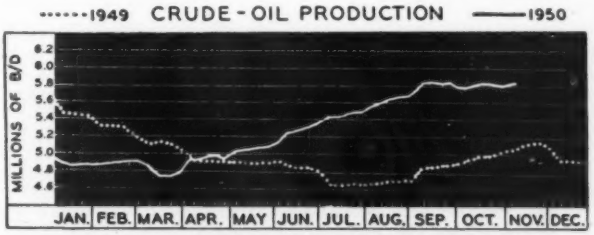
*Not including 99,530 bbl. condensate. †Including 30,708,020 bbl. condensate.

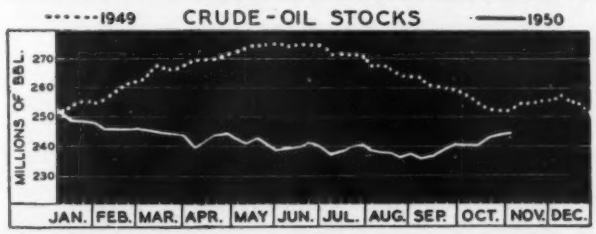
CRUDE-OIL STOCKS BY STATES OF ORIGIN*

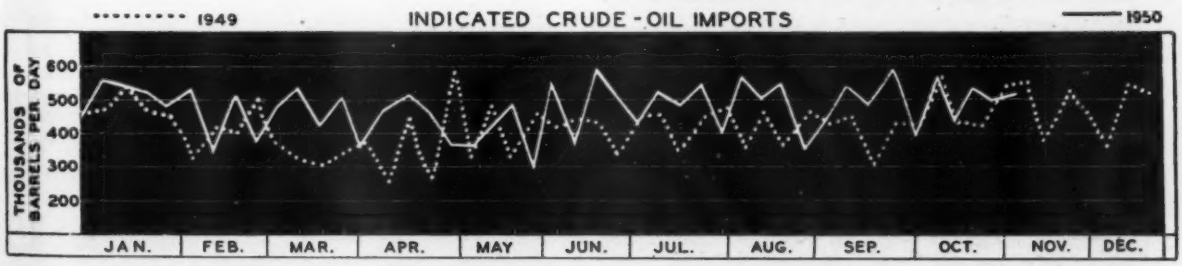
(Thousands of barrels)

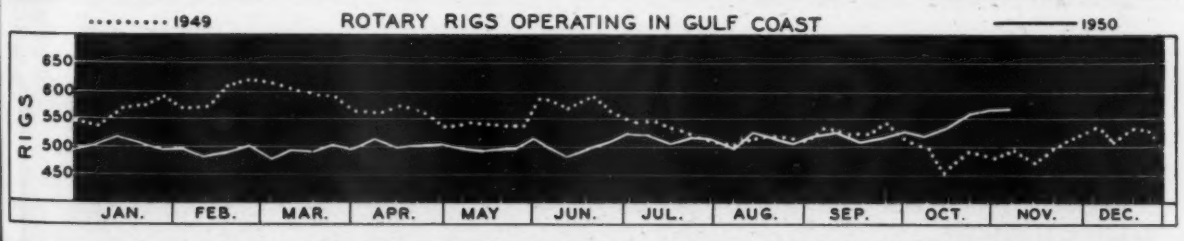
	Nov. 4, 1950	Oct. 28, 1950	Nov. 5, 1949
Pennsylvania Grade	2,254	2,244	3,188
Other Appalachian	1,388	1,297	1,840
Illinois, Indiana, Michigan	9,674	9,375	11,395
Arkansas	2,357	2,420	2,574
Louisiana	13,839	13,630	13,062
North	3,085	3,083	3,150
Gulf	10,754	10,547	9,912
Mississippi	2,135	2,318	2,518
New Mexico	6,959	6,837	7,443
Oklahoma and Kansas	37,834	38,256	36,738
Texas	120,337	120,134	115,567
East Texas	14,618	14,954	16,463
West Texas	45,923	45,939	44,357
Texas Gulf	28,863	29,251	28,887
Other Texas	30,933	29,950	25,860
Rocky Mountain	11,078	11,084	14,111
California	30,537	30,625	37,646
Foreign	6,503	6,585	8,039
Total	244,935	244,805	254,121

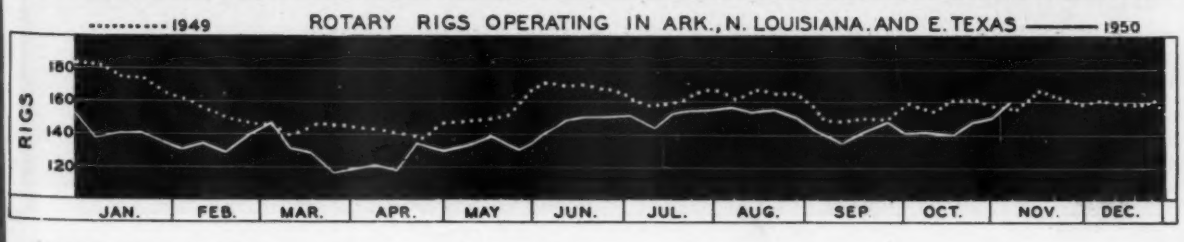
*Bureau of Mines.









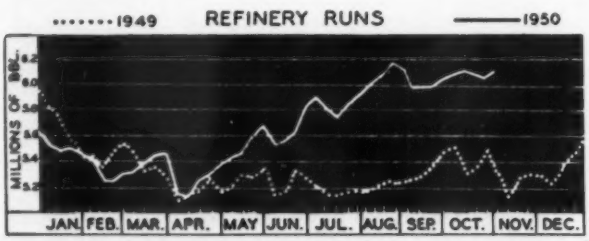

1949 ROTARY RIGS OPERATING IN ARK., N. LOUISIANA AND E. TEXAS 1950
RIGS
180
160
140
120
JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.

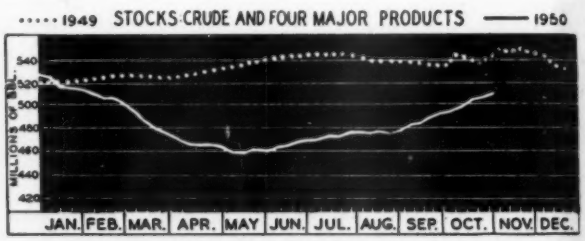
A.P.I. REFINERY REPORT, NOVEMBER 4

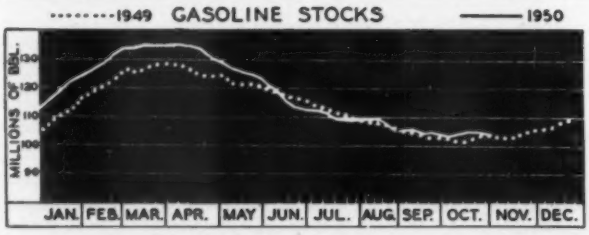
(Thousands of barrels)

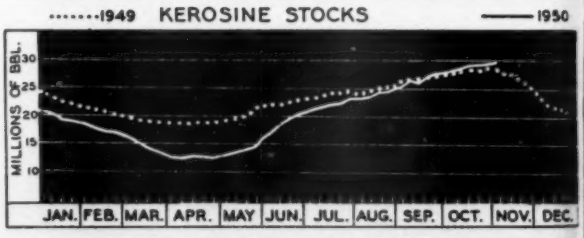
District—	Daily avg. crude runs	Daily average production				Stocks at refineries, bulk terminals, in transit and in pipe lines				Bureau of Mines, November 4				
		Gasoline*	Kerosine	Distillate	Residual	Gasoline†	Kerosine	Distillate	Residual	Daily avg. crude runs	Daily average production: Gasoline*	Kerosine	Distillate	Residual
East Coast	997	337.7	35.6	251.1	205.1	24,847	11,449	27,507	11,622	760	322.0	26.7	158.7	190.4
Appalachian:														
District 1	94	41.9	7.1	14.0	11.0	2,617	511	991	477	92	41.7	5.8	12.4	9.3
District 2	70	37.9	3.0	7.0	16.3	1,185	228	297	162	55	26.5	3.5	5.8	11.0
Ind., Ill., Ky.	1,075	593.8	71.4	184.4	145.8	20,645	6,014	15,008	5,075	932	492.5	62.7	144.7	163.9
Okla., Kans., Mo.	488	260.8	18.6	101.9	56.6	10,323	1,476	9,079	1,383	426	240.7	15.4	87.6	58.9
Inland Texas	203	141.6	12.4	34.1	39.1	3,302	535	1,556	663	207	143.2	12.7	25.6	41.8
Texas Gulf Coast	1,500	672.1	105.2	354.9	278.4	16,460	4,432	13,511	6,474	1,279	615.5	104.0	253.2	230.4
La. Gulf Coast	504	231.4	50.2	111.6	69.6	6,330	2,876	4,093	2,249	443	228.9	53.6	103.6	59.4
N. La. and Ark.	73	25.7	7.3	15.0	4.6	2,136	483	917	183	81	31.9	7.8	11.1	16.2
Rocky Mountain:														
New Mexico	14	7.3	.4	2.6	3.7	88	25	40	22	12	7.0	.4	1.8	3.7
Other Rocky Mtn.	177	79.6	8.1	33.6	47.9	2,633	417	2,000	750	162	76.2	6.5	25.7	32.9
California	922	449.6	10.6	139.4	329.6	13,784	669	11,887	15,629	844	357.8	10.0	132.2	342.7
November 4, 1950	6,117	2,879.4	329.9	1,249.6	1,207.7	104,350	29,115	86,886	44,689	5,293	2,593.9	309.1	962.4	1,180.4
October 28, 1950	6,051	2,839.7	326.9	1,179.9	1,207.0	105,062	28,634	84,057	44,310	.....	.....	.....	.....	.....
November 5, 1949	5,314	2,637.1	302.0	1,028.0	1,104.0	104,257	28,399	92,038	69,192	.....	.....	.....	.....	.....

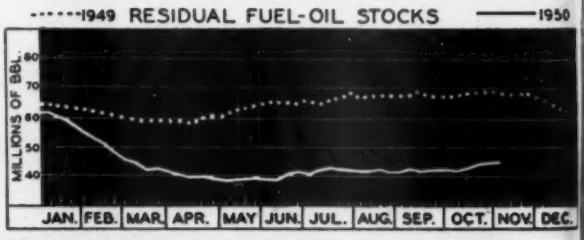
*At refineries including natural blended. †Finished and unfinished.

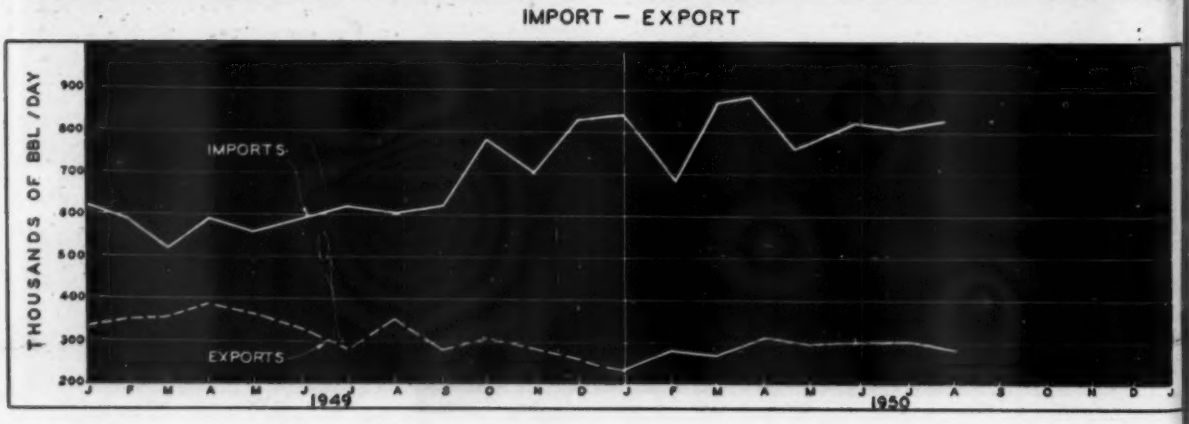












CRUDE PRICES

GRAVITY SCHEDULE

	Signal Hill, Calif.‡	Oklahoma, Kansas	Gulf Coast Tex.*	West Tex.†
18-18.9	$1.76	....	....	....
19-19.9	1.83	....	....	....
20-20.9	1.90	$2.25	....	$2.12
21-21.9	1.97	2.27	....	2.14
22-22.9	2.04	2.29	....	2.16
23-23.9	2.10	2.31	....	2.18
24-24.9	2.17	2.33	$2.56	2.20
25-25.9	2.24	2.35	2.58	2.22
26-26.9	2.31	2.37	2.60	2.24
27-27.9	2.37	2.39	2.62	2.26
28-28.9	2.42	2.41	2.64	2.28
29-29.9	2.48	2.43	2.66	2.30
30-30.9	2.54	2.45	2.68	2.32
31-31.9	2.59	2.47	2.70	2.34
32-32.9	2.64	2.49	2.72	2.36
33-33.9	....	2.51	2.74	2.38
34-34.9	....	2.53	2.76	2.40
35-35.9	....	2.55	2.78	2.42
36-36.9	....	2.57	2.80	2.44
37-37.9	....	2.59	2.82	2.46
38-38.9	....	2.61	2.84	2.48
39-39.9	....	2.63	2.86	2.50
40 and above	....	2.65	2.88	2.52

*For crude from Daboval, El Campo, and Sand Point.

†Includes Lea County, New Mexico. Last general price change represented a 50-cent increase becoming effective December 6, 1947.

‡Standard Oil Co. of California.

FLAT CRUDE PRICES

Representative posted schedules per barrel	
East Texas†	$2.65
Kettleman Hills, California*	2.77
Beauregard Parish	2.60
Illinois Basin	2.77
Pecos County, Texas (Yates)	2.35
Bradford, Pennsylvania	4.10
Eastern Ill. and Western Ind.†	2.77
Tomball, Texas Gulf Coast	2.83

*37°-37.9°. †35° and above.

HEAVY-FUEL prices in New York Harbor settled to a single level with the last independent marketer dropping back to the generally posted price of $2.15 per barrel. Based on Gulf Coast spot prices and high tanker rates, some suppliers feel that higher prices on the eastern markets are justified, but as long as supplies are available at $2.15 it is difficult to move heavy fuel at $2.25. The current Gulf-East Coast rate for dirty tankers is about 70 cents a barrel while the spread between Gulf Coast and New York Harbor residual spot prices is only about 40 cents.

Demand for light fuels on the eastern markets is fluctuating with changes in the weather. The increase in sales during the few days of cold weather at the first of the month was followed by softer markets under the influence of warm weather. Another general cold wave moved over the high-demand areas of the country on the second week end of the month, bringing firmer distillate markets. Even during the short warm period, light-fuel prices on the eastern markets were shaded only by suppliers with storage problems since replacement costs have risen with the tanker market.

Continued high demand for gasoline in the Mid-Continent and North Central areas has resulted in a steady gasoline market at the tank-car level. Group 3 spot prices have held for all grades of gasoline with the possible exception of recycle gasoline. Gasoline stocks for the country as a whole declined in the week ended November 4 to about the level of corresponding date last year.

Shipping instructions for No. 2 fuel from the Mid-Continent were increasing as a result of the second cold wave since the first of the month. Residual-fuel movement has been good at firm prices.

REPRESENTATIVE QUOTATIONS

Representative spot-market quotation of leading suppliers as of November 13, 1950. Figures are f.o.b. plant for tank-car shipments in cents per gallon, except for residual fuel oil which shows the price per barrel and wax, in cents per pound.

GASOLINE, KEROSINE, AND FUEL OILS

	Mid-Continent Group 3	New York Harbor (barge)	Texas Gulf Coast
Regular gasoline, 80-82 octane	10⅜-10½	11.75-12.75	10¾-11
Premium gasoline, 86-88 octane	11¼-11½	13-13.75	11½-12
42-44 w.w. kerosine	8⅞-9⅛	10-10.1	8½-8¾
No. 2 straw fuel oil	8⅛-8⅜	9	7½-7¾
No. 6 residual	$1.65-1.75	$2.15	$1.75-1.85

NATURAL GASOLINE

	Group 3	North Texas	N. La.
Grade 26-70	6⅜	5⅞	6⅛
Grade 18-55	7.65	7.15	7.4

LUBRICATING OILS

South Texas

200 vis., No. 2-3 neutral	12.5-13
750 vis., No. 3-4 neutral	14.75
2,000 No. 5-6 neutral	16.5

LUBRICATING OILS

Mid-Continent

150-160 vis., D bright stock 0-10 pp.	27-28
200 vis., No. 3 neutral, 0-10 pp.	16.5-18.5

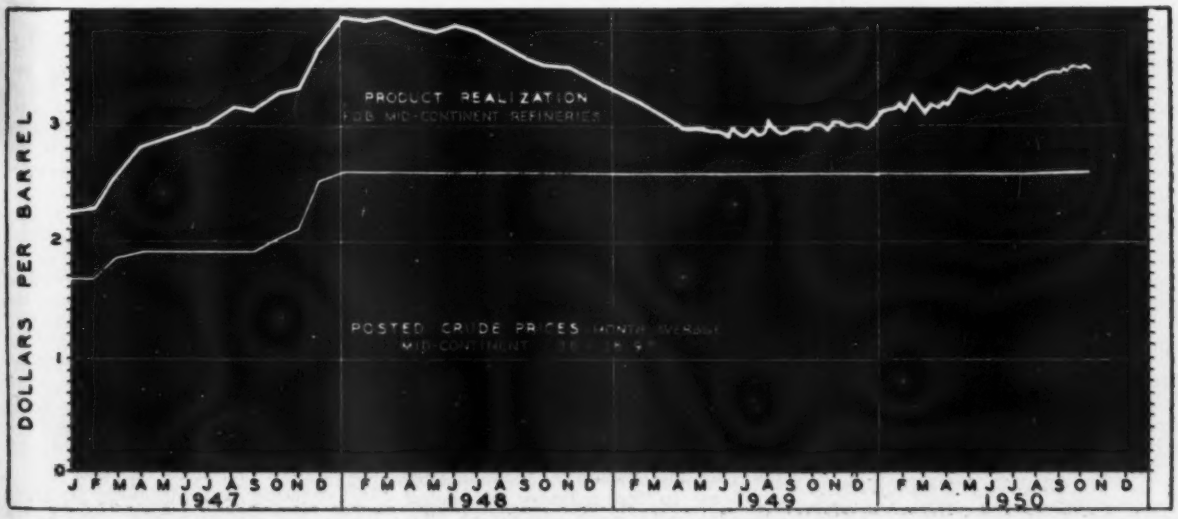
Western Pennsylvania

145-155 vis., 10 p.t. bright stock	29.5
180 vis., 0 p.t. neutral	30.5

WAX

Mid-Continent

132-134 A.M.P.	5.8



In this trend chart refinery realization is based on average Mid-Continent grade crude oil (not 38° gravity only) and average prices for refinery products as published in The Oil and Gas Journal basis Oklahoma (Group 3). Refinery yields confined to gasoline, kerosine, distillate, and fuel oil. Realization averaged $3.48 for week ended November 4, $3.52 for previous week, and $3.02 for November 1949.

INTERNATIONAL

Middle East Prices

U. S. competition, products price based independently of Western Hemisphere, to determine structure, Levy says

Dahl M. Duff

THE ultimate future price structure for Middle East oil will consist of a crude price determined by competition with United States and Caribbean sources and a products price based independently of Western Hemisphere quotations, according to Walter J. Levy, New York petroleum economist and former head of the oil branch of the Economic Cooperation Administration.

Levy made it clear that at the present time the Persian Gulf price pattern is in his judgment in a transitional state and that the predictions as to the final likely structure apply only when Eastern Hemisphere oil has settled down to a firm basis at some future date. His opinions were predicated on several developments, including construction of sufficient pipe-line capacity to the Eastern Mediterranean in the next few years to supply most European and possibly some Western Hemisphere crude requirements, completion of the European refinery construction program, ultimate relatively small shipments of crude east of Suez but the bulk of the Persian Gulf product production going to these areas, and only limited crude and products imports from the Western Hemisphere into the Eastern Hemisphere.

When these supply-and-demand relationships have finally evolved, Levy said, the Middle East crude-oil price, f.o.b. Eastern Mediterranean, will very likely be determined by a fluctuation between a low which will allow Middle East crude to compete with United States and Caribbean crude on the United States East Coast, and a high which would allow Caribbean crude to compete with Middle East crude in western Europe. On the basis of present West Texas crude prices and tanker rates at U. S. Maritime Commission plus 30 per cent, this range would be between $2.67 and $2.10 per barrel, f.o.b., Eastern Mediterranean. Present price, f.o.b. Persian Gulf, is about $1.75.

Struggle seen.—Levy said that the future probably will see a continuous struggle between Middle East and Western Hemisphere, mostly Caribbean, crude for outlets on the fringe of the European and Western Hemisphere markets. Under these marginal supply-and-demand influences, the Middle East crude price will be at the high of the range if Western Hemisphere shipments into the Eastern Hemisphere tend to exceed substantially Middle East shipments into the Western Hemisphere. The Middle East price will be near the low if this oil moves in substantial volume into the Western Hemisphere.

Discussing the effect of the completion of the Eastern Mediterranean pipe lines, Levy said this would mean that the high and low limits would be determined f.o.b. Eastern Mediterranean on the basis of tanker transportation rates from Mediterranean ports to marginal markets, instead of f.o.b. Persian Gulf plus tanker rates from that area. For the limited quantities of crude moving east of Suez, the price would be the Eastern Mediterranean price minus a pipe-line charge to back up this crude to the Persian Gulf exporting centers.

Marginal market.—As for Persian Gulf products prices, Levy pointed out the fact that the European refinery-construction program is still incomplete makes necessary at present the import of large quantities of products into this region, but that ultimately Europe will be only a marginal market for products. When that condition materializes, it is likely that the price for refined products, f.o.b. Persian Gulf, will be determined independently on the basis of all relevant factors, such as the price of Middle East crude oil, cost of operations, amortization and depreciation, replacement value of facilities, profits, including, of course, the risk-of-investment factor.

The ultimate pricing of products out of Persian Gulf refineries as foreseen by the economist would be in marked contrast to the present system under which prices are set by the quotations in effect on the United States Gulf Coast. This has been the traditional method, inaugurated long before such postwar developments as prospective refining self-sufficiency of Europe and the rise of a crude-production source in the Middle East virtually sufficient to meet all the needs of the Eastern Hemisphere. Levy in his discussion pointed out that it cannot now be predicted how the final resulting Persian Gulf products price will compare with the then current United States price. In Europe, when the ultimate price structure evolves, refined products prices will find their own level on the basis of delivered cost of Middle East crude, local operating expenses, and other pertinent factors not on the basis of United States prices plus transportation from the Gulf or Caribbean.

EUROPE

Soviet Oil Progress

Red minister says big strides being made in industry, but fails to give specific figures on what's going on

Dahl M. Duff

THE drilling of several holes off a central shaft, successful use of secondary-recovery techniques, offshore operations from platforms, and other accomplishments of the Russian oil industry have been claimed in an article in Izvestia by N. Baibakov, Soviet minister for the oil industry.

Without giving specific figures, the minister recited various achievements of the industry and in general emphasized the important place being given to petroleum development in the Russian economy. Technological problems in the industry are being overcome with much success, he said.

Twice as many wells were drilled in 1949 in Russia as before the war, and the rate of exploratory drilling is three times the prewar level, he said. New methods have achieved a drilling rate of 1,000 to 1,500 m. (3,300 to 4,900 ft.) per rig per month in areas where the prewar level never exceeded 200 m.

Competition has arisen to decrease drilling time and to eliminate the lag between completing one well and commencing another. Several oil workers, the minister said, have organized a complex program for all drilling and derrick-erection work, thus doubling production. Several engineers were cited for having introduced new methods of assembling and erecting rig equipment in large units. The system is now being widely used.

Slant drilling.—More than 1,000,000

additional tons of oil were obtained by slant drilling in Baku and Krasnokamsk with a considerable saving in cost, Baibakov continued. He said there had been considerable success in deep drilling as well as in producing apparently exhausted fields and formations by secondary recovery. Development of the oil strata under the Caspian Sea was a complex technical problem which was solved by working from separate units built at sea and from piers built along the shore. Among outstanding achievements are the wells located in the sea off the Azerbaidshan and the Dagestan republics.

Imports stopped. — Due to successes in equipment and machinery construction, the industry no longer has to import materials. Baibakov said this was one of the most important results of the postwar 5-year plan. The productive capacity per worker in oil-machinery construction was twice as great in 1949 as in 1946. Oil-refinery workers, he said, have a particularly responsible task, since Stalin's plan for improving the selection of light-oil products and improving the assortment and quality of all oil products must be included in the technological schedules of all new and reconstructed plants.

Production.—As for production, the minister asserted that Soviet oil workers in the fourth quarter of 1949 exceeded the quota planned for 1950 under the 5-year plan. In the eastern part of the country, he said, oil development has increased several times over 1940. Development of oil and gas on a strictly scientific basis, taking into consideration the hydrodynamic, geological, and economic factors involved, is possible only under planned socialist economy, the Russian official declared. In Russia, new scientific methods resulted in the production of more than 1,000,000 tons additional oil in 1949.

Speedup needed.—Oil development in Russia must be speeded up in order to obtain the oil production of 60,000,000 tons (about 1,200,000 bbl. daily) in the course of the next 5 years as has been proposed, he said. New methods and use of accelerated drilling must be expanded, and use of drilling equipment must be increased with elimination of organization breakdowns and accidents.

Production workers and scientific-research organizations should work with the industry to determine the most suitable technical and economic period for repair work on wells and on the basis of this indicate how planned preventive-maintenance should be organized. The most pressing tasks now faced are to accumulate steadily the active reserves of wells and improve production of wells now in operation, he said.

Guests inspecting the reconstructed refinery of Anglo-Iranian Oil Co., Ltd., at Hamburg, Germany. In the foreground are F. C. C. Morris, a managing director of Anglo-Iranian and chairman of BP Benzin und Petroleum, left, and Dr. Dunlop, British commissioner for Hamburg.

Refinery Opened

Anglo-Iranian's Hamburg facilities rehabilitated

THE reconstructed "Eurotank" refinery at Hamburg, Germany, which was acquired by Anglo-Iranian Oil Co., Ltd., in 1948, has been formally reopened.

Originally built by a German company in 1934, the plant was badly damaged during the war but was restored to limited use in February 1949. Its rehabilitation, giving a crude capacity of 575,000 tons a year (about 12,000 bbl. daily), has now been completed.

The refinery, which formerly belonged to Davis & Co., Inc., New York, is situated close to the new Hamburg oil harbor on the Elbe River. The now rebuilt plant forms an essential part of the over-all German refining program. The company operating the refinery as well as the Anglo-Iranian distributing organization in Germany is BP Benzin und Petroleum G.m.b.H., formerly called Olex.

Facilities.—Facilities at the refinery comprise a Foster Wheeler atmospheric topping plant with a daily capacity of 750 tons (about 5,300 bbl. daily) and a Winkler-Koch combined topping and cracking plant of about 1,250-ton daily capacity (about 8,000 bbl. daily).

Guests at the 2-day dedication program for the reconstructed refinery included a number of senior British, German, and foreign officials, and members of the German oil industry. Among them was F. G. C. Morris, a managing director of Anglo-Iranian.

LATIN AMERICA

Junta Member Assassinated

Lt. Col. Carlos Delagado Chaulbaud, leading member of the three-man military junta governing Venezuela, was shot and killed by an assassin early this week.

Reports from Caracas said the shooting apparently had not signaled any attempted political uprising in the country. The remaining two members of the junta, Colonels Perez Jiminez Gomez and Llovera Paez, continued in control of the government.

Immediate views in the oil industry on the likely repercussions varied. It was, however, believed existing policies toward Venezuela's major industry would be continued without significant change. Perez Jiminez is reported to have the army strongly in control and believed able to cope with any attempt to overthrow the existing regime.

Chaulbaud was in general warmly regarded in the industry. He was considered to be pro-American and an advocate of oil operation free from undue government interference.

Chilean Refinery Considered

Corporacion de Fomento, Santiago, Chile, is considering plans for a refinery in that country with a daily capacity of 15,000 bbl.

Until recently Chile's refining facilities consisted only of a few small topping plants totaling less than 500 bbl. daily. These refineries are now out of commission, according to a late report from Corporacion de Fomento.

EQUIPMENT MEN . . . in the News

Woods Named Purchasing Agent by Brewster Co.

Charles E. Woods has been appointed purchasing agent of Brewster Co., Shreveport, drilling-equipment manufacturers, according to a recent announcement by Harry B. Marioneaux, general manager.

Woods has been with Brewster since 1925, and was formerly in charge of production control.

Aldrich Pump Appoints McPeake as Sales Manager

R. H. McPeake has been appointed sales manager of The Aldrich Pump Co., Allentown, Pa. McPeake, a graduate of U. S. Naval Academy, had 8 years' oil-field experience with Standard Oil Co. (N. J.) in both the Mid-Continent and Peruvian fields. In 1938 he left Standard Oil to join The Oil Well Supply Co., where he became export sales manager. In 1945, McPeake became a partner in an industrial engineering and importing firm in Buenos Aires, representing American manufacturers.

Garber to Direct Thew Shovel Sales Activities

A. W. Smythe, vice president and general manager of The Thew Shovel Co., Lorain, Ohio, has announced that M. B. Garber has assumed the position of director of sales for the company.

Garber announced the appointment of J. T. Cushing as sales manager, in complete charge of all domestic sales except those to the federal Government. Robert Maynard remains in his present position as export manager.

Q. J. Winsor relinquishes his present duties as assistant general manager and assumes a new position under the general manager with the title of manager of development sales.

Shand & Jurs Moves Chicago Quarters

The Chicago quarters of Shand & Jurs Co., Berkeley, Calif., manufacturers of petroleum storage, transportation, safety, and drilling equipment, have been moved to 10409 South Western Avenue, Chicago 43.

The new quarters are said to be complete with their own warehouse and storage facilities. All mail and stock shipments addressed to the Shand & Jurs Chicago branch will be handled from this new location.

United Geophysical Makes Sales Department Changes

United Geophysical Co. has announced several recent developments in its sales organization. The company office at Midland, Tex., has been moved to 407 North Garfield.

In addition, Duncan D. Robinson has been appointed as party chief of United's seismic crew in Kuwait, Persian Gulf, and L. A. Martin has returned from an extended trip to the Middle East where he has been inspecting United's operations in that area.

Whitcomb, Davis Advanced By Kelley Manufacturing

James L. Whitcomb, formerly sales manager, has been made general manager of Kelley Manufacturing Co., Houston, and J. Keith Davis, formerly sales representative, has been named sales manager, it has been announced by Mrs. Edward W. Kelley, president of the corporation, which manufactures and distributes steel products.

Whitcomb has been with the company for over 5 years, and is a graduate of Brown University where he majored in economics. He was formerly manager of the Retail Dry Goods Association of New York, and later was associated with Eastern Airlines as division public-relations manager.

J. Keith Davis has been with Kelley for over 12 years, most of which was spent in the North Texas area.

James L. Whitcomb and J. Keith Davis are Kelley Manufacturing Co.'s new general manager and new sales manager.

Marsteller Resigns to Form New Consulting Firm

Wm. A. Marsteller has resigned, effective January 1, as vice president of Rockwell Manufacturing Co. of Pittsburgh and as vice president and director of Edward Valves, Inc., East Chicago, Ind., to establish The Marsteller Co., consultants in marketing and advertising. The new firm will be located in Chicago, after the first of the year. Marsteller has been responsible for advertising, market research, and sales promotion for Rockwell and its 14 divisions. Recently in an executive advisory capacity with Edward Valves, he was formerly in charge of sales, advertising, and employe relations for this company.

McDonald to Latin America

C. B. McDonald, vice president of A-1 Bit & Tool Co., left Houston November 2 for a 2-month trip to Latin America. Most of his time will be spent in Venezuela.

Tulsa Testing Laboratories Buy Born Testing Equipment

James B. Davis, director of Tulsa Testing Laboratory, has announced the recent purchase by his firm of the oil and gas-testing facilities and business formerly operated by Born Engineering Co.

T. L. Carson, who has been in charge of the laboratory for Born Engineering, will continue as its head under Tulsa testing laboratories. Facilities include Podbielniak gas-testing equipment for running low-temperature fractional distillation tests, and automatic calorimeters for determining the gross heating value of natural gas.

Other testing services offered by the firm include: metals, chemicals, asphalt, concrete, soils, cores. It also maintains mobile X-ray and gamma-ray equipment.

Jefferson Chemical to Manufacture New Products

Jefferson Chemical Co., Inc., has announced that it will begin manufacturing monoethanolamine, diethanolamine, and triethanolamine next year in its plant at Port Neches, Tex. A contract has been awarded to C. F. Braun & Co. for erection of a unit for the ethanolamines, and completion is scheduled for the latter half of 1951.

One of the raw materials which Jefferson will employ in manufacturing the ethanolamines is ethylene oxide, which it has been producing at the Port Neches location since 1948. In addition to ethylene oxide, Jefferson is currently producing ethylene glycol, diethylene glycol, ethylene dichloride, and related products.

Jefferson Chemical Co., Inc., was formed in 1944 by The Texas Co. and American Cyanamid Co. to manufacture chemicals from petroleum raw materials.

California Buda Firm Occupies New Quarters

Buda Engine & Equipment Co., Inc., in California, Bakersfield, has moved into a new and larger building, according to Don L. Chumbley, district manager.

Larger quarters became necessary in order better to service Buda oilfield engines in service in Kern County. Since the company is also the California distributor for Gaso Pump & Burner Manufacturing Co., Tulsa, the new quarters will house service and engineering facilities for Gaso pumps in addition to Buda engines.

Foy Made Head of Koppers Tar Products Division

J. N. Forker, vice president and general manager of the Tar Products Division, Koppers Co., Inc., since 1946, will retire on December 1, and Fred C. Foy, who has headed the Koppers sales department, will succeed him, it has been announced by Brehon Somervell, Koppers president.

Foy has been elected a vice president of Koppers and has been relieved as manager of the sales department in order to prepare to assume the division general managership. Cooke Bausman, Jr., who has been assistant to Foy, has been appointed acting manager of the sales department effective immediately.

In his new position, Foy will direct all activities of the Tar Products Division which operates 22 tar-processing plants in 14 states. The new general manager of the division joined Koppers in 1948, coming from J. Walter Thompson Co. of which he was a vice president and manager of its Detroit office. Since his appointment as vice president and manager of Koppers sales department, Foy has directed the development of Koppers' sales policies and has coordinated sales efforts in its six operating divisions.

Bausman joined Koppers in September 1948 as assistant manager of the sales department. He was with Mellon Securities Corp. before World War II. After the war, he became general manager of the Pennsylvania Ultra-violet Co. until accepting the position with Koppers.

Baldwin-Hill Creates New Public Utilities Division

Baldwin-Hill Co., insulation manufacturers with plants at Trenton, N. J., Kalamazoo, Mich., and Huntington, Ind., has created a public utilities division of industrial sales headed by P. A. Bell, with offices in the Reynolds Building, Jackson, Mich. M. M. Wilson continues as general manager of industrial sales, with E. R. Stevens, vice president in charge of sales.

Before coming with Baldwin-Hill

(Continued on page 415)

Dallas Bank Entertains Oil Men on Anniversary

Joining in dual celebration of the seventy-fifth anniversary of the First National Bank in Dallas and of their many years of mutually enjoyable and beneficial business relations, over 1,000 oil men, government dignitaries, and bankers met in the Crystal Ballroom of the Baker Hotel on Friday, October 27, for an evening of entertainment.

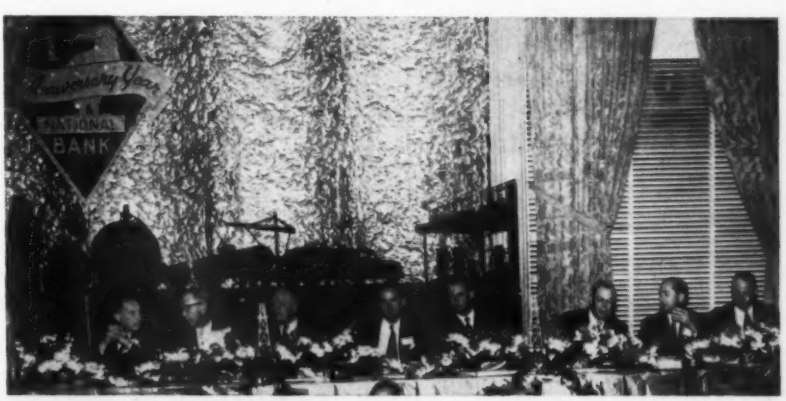
Setting the theme of the occasion Eugene McElvaney, vice president in charge of the First National's oil department and toastmaster for the evening, declared, "When an institution reaches its seventy-fifth anniversary, it is a pretty good place to pay tribute in all humility to those who have made you great."

Among those present to share in the celebration of the First National's seventy-fifth anniversary were: Gov. Allan Shivers, Sen. Tom Connally, Reps. Ed Gossett and Ken Regan; Frank Porter, president of the American Petroleum Institute; Robert Anderson, president of Texas Mid-Continent Oil and Gas Association; Jake Hamon, president of General Mid-Continent Oil and Gas Association; Ed Warren, president of the Independent Petroleum Association of America; D. A. Hulcy, president of American Gas Association; A. W. Thompson, president of the American Association of Oilwell Drilling Contractors; R. L. Foree, president of the Texas Independent Producers and Royalty Owners Association, and Elliott V. Bell, publisher and editor of Business Week Magazine.

Nathan Adams, honorary chairman of the board and the guiding hand of the First National for the better part of its 75 years. was introduced to and received a standing ovation from the men whose business success he has shared.

It was Adams who instituted the First National's policy of lending money on oil that is still below the ground. The first loan following this principle was made in 1932 in the amount of $50,000.00; since then the First National has loaned over 1 billion dollars to the men of the nation's oil and gas business.

After introducing Adams, Toastmaster McElvaney turned the program over to First National President Ben Wooten who voiced sincere praise to the men in the industry.



At the speakers' table for the oil dinner at Baker Hotel given by First National Bank in Dallas are: Eugene McElvaney, vice president in charge of First National's oil department and toastmaster of party; Ben H. Wooten, president, First National Bank in Dallas; Frank Porter, president, American Petroleum Institute; Gov. Allan Shivers; R. B. Anderson, president, Texas Mid-Continent Oil and Gas Association; D. A. Hulcy, president, American Gas Association; W. J. Murray, chairman of Texas Railroad Commission, and Ken Regan, congressman from Midland, Tex.

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EQUIPMENT FOR SALE

USED ROTARY AND CABLE TOOL DRILLING TOOLS, WIRE LINES, E. A. KELLY, BOX 861, OKLAHOMA CITY. PHONE 5-6407.

WELL equipment. New and used spudders, rotaries, core drills, all sizes and types. Cable tools, drill pipe, bits, pipe. Fishing tools rented. Everything for well service. Pressey & Son, Pueblo, Colo.

FOR SALE: Two No. 2-A National Drilling Machines with steel masts. Located at the Davis Pipe and Supply yard at Chanute, Kansas.

TWO Gardner-Denver Compressor Units size 12 x 11 and 4¾ x 11, direct connected with 100 HP electric RPM motor, complete with all equipment; located at Refugio, Texas; in service forty-five days. Will take reasonable discount. Clymore Petroleum Corporation, 238 Kaffie Building, Corpus Christi, Texas.

FOR SALE: Twelve inch bits, bailer wrenches, five inch stems, other tools. Albert Breisach, Paola, Kansas.

FOR SALE: 3 complete strings of cable tools, together with 3 Buda drilling engines. Much new material, including bits, drilling lines, etc. Tools located at Russell, Kansas. Harry Gore, 400 Brown Bldg., Wichita, Kansas.

FOR SALE: One T5A-80-D Lufkin Pumping Unit with XAHU Waukesha Engine slide rails and V Belts, Two 4" x 5" Myers Piston pumps with engines and skids, 1—6¼" x 30' American Drill Collar, 1200' 2" Line Pipe and a small amount of 5½" H-40 Seamless casing. Phone 1072 or write P. O. Box No. 127, Mt. Vernon, Illinois.

8-IN. PIPE FOR SALE

Approximately 200 miles of 8" 29.02# line pipe being taken up. This pipe was used in a 650# Pressure Products Line. Pipe subject to prior sales f.o.b. Pittsburgh District.

Wire or Write if interested.

Box 574, Tulsa, Oklahoma

OILWELL No. 5 draw works, two D-13000 Caterpillar, Oilwell 27½" rotary table, Ideal model B 7¼" x 14" pump. Sale price $15,000.00. Adams Drilling Company, Brush, Colorado.

ONE electric magnetic fishing tool outfit, with magnets capable of lifting 1,000 pounds, adaptable for fishing junk like drilling cones and such out of oil wells. 2507 Mercantile Bank Building, Dallas, Tex.

1—4'0" ID x 40'-6" x 1¼" thick tower; 1—7'-0" ID x 57' x ½" thick tower, 19 CI bubble trays; 1—7'-6" ID x ½" thick tower, 25 CI bubble trays; 1—2'-6" dia. x 40'-3 compartment tower, 15 bubble trays. Tri-State Supply Company, Box 610, Mt. Pleasant, Texas.

NATIONAL "50" Compound Double Drum Rig 126' Cantilever L. C. Moore Mast. 10' substructure. 6,000' 4½" drill pipe. This rig complete and in excellent condition. P. O. Box 205, Sta. B, Bakersfield, California.

F-8 FORD Super Cementing and Acidizing Unit complete; 2 Gaso pumps, 4½ x 10 and 3¼ x 10, with brass liners; split jackshaft and 135 HP Waukesha motor; measuring line, swedges, plugs and containers. Severin Johnson, Box 1005, Coleman, Texas.

FOR SALE: Model S Cardwell Drawworks Powered with WAK Waukesha 5 Speed Transmission 10 Speeds Forward, Good Condition. Longhorn Supply Company, Box 4149, Houston, Texas.

FOR SALE

60,000 feet of 16" used plain end line pipe, ¼" wall, Mt. Gilead, Ohio.

20,000 feet of 10¾" used line pipe, ¼" wall, Loudonville, Ohio.

4,000 feet of 6⅝", 19# used line pipe, T&C.

ROGERS AND WRIGHT COMPANY
710 Peoples Building
Charleston, West Virginia
(Phone 30171)

FOR SALE: Three D-13000 Caterpillar Diesel Engines, two compounded. Priced for quick sale. A. D. ALLISON & CO., INC., 715 Brown Building, Wichita 2, Kansas.

CATERPILLAR D-8 with Hydraulic Bulldozer, excellent condition, $8500. Caterpillar D-7 with Hydraulic Bulldozer, 300 hours $11,000. Caterpillar D-6 with Cable Bulldozer, 300 hours, $9500.00 All above guaranteed. Martin Tractor Co., Phone 73, Chanute, Kansas.

71-STAR-SPEED-SPUDDER complete with tools, truck mounted. New drilling line. Write C. A. McMillen, 117 East Main St., Titusville, Penna., Phone 31351 (evening).

DRILLING rig located at Greggton, Texas, yard, and consisting of complete steam rotary drilling rig without drill pipe, including 2 120 H.P. oil well boilers, 1 6" Union Tool unitized draw works, 1 12x12 Ajax roller bearing steam engine, 1 14½x7½x18 Ideal mud pump, Ideal rotary table, swivel, crown block, traveling block, etc. Contact Rudco Oil & Gas Company, Box 2018, Tyler, Texas.

Several Army Surplus 4½" x 6" Gaso Duplex 1860 Pumps — two piece skid mounted with Chrysler 8 cylinder engines. Will sell pumps only or complete units about half price.

H. H. COFFIELD
ATTN.: W. H. Orr
Phones: 132—Rockdale, Texas
A-86054—Houston, Texas

RECONDITIONED SEAMLESS TUBING

1 5/16" OD—150,000 feet
1½" OD—100,000 feet
2" OD—100,000 feet
2¼" OD— 55,000 feet
3¼" OD— 65,000 feet

Approximately 9 and 10 gauge wall
Single Random Lengths
Plain ends—beveled for welding
Write—Wire—Phone

Sonken-Galamba Corp.
2nd and Riverview (X-654)
THatcher 9243 Kansas City 16, Kansas

FOR SALE

100 Tons 3½" Used Boiler Tubes, A-1 Condition—Free of Scale and Pits—18 Ft. Long.

GREENPOINT IRON & PIPE CO., INC.
Stagg & Bogart Streets
Brooklyn 6, New York

PIPE FOR SALE

Approx. 25,000' of 8" OD, DRL, used LW line pipe.

Approx. 10,000' of 4½" OD, R-2, used seamless pipe, new 8 rd. thrds. and new regular casing couplings.

Approx. 5,500' of 5 9/16" OD, R-2, used seamless pipe, new 8 rd. thrds. and new regular 5½" casing couplings.

Approx. 6,500' of 7" OD, 28#, R-2, used seamless casing, new 8 rd. thrds. and new regular casing couplings.

Approx. 1,600' of 24" OD, non tested seamless pipe.

BROWN PIPE & MACHINERY CO.
P.O. Box 2368, Phone 3-9391, Corpus Christi, Texas

EQUIPMENT FOR SALE

FOR CABLE TOOLS
DEGEN PIPE AND SUPPLY CO
Box 107, Red Fork Station, Tulsa, Oklahoma

6,218 FEET 7" O.D. 17# new seamless casing H-40 Rg 2 @ 2.90 ft. Phone 5-8850, Tulsa.

FOR SALE: Diesel powered Star Spudder No. 243 2500' complete with tools and lines now operating in NE Oklahoma. Box D-752, The Oil and Gas Journal, Tulsa, Oklahoma.

AMPHIBIOUS airplane: Eight place twin-engine Grumman Goose for sale or lease. Formerly owned by large oil company, excellent condition. Richard French, Genesee Airport, R.D. 2, Rochester, New York.

DAVEY Air Compressor, 30 KW Alternating Generator, 2 2 KW Generators, M & S quart canning machine, Lincoln welder, concrete mixer, pumps and other surplus equipment. Oklahoma Refining Company, Seminole.

9500 FEET electric conducting cable, new, never used, prestressed and preformed, 48,000 lbs. breaking strength. 2507 Mercantile Bank Building, Dallas, Texas.

BOILERS

Largest Stock in South

4 ea. HWW Cross Drum Steel Header (sectional) 1934 Water Tube, 500 HP, 350# WP, with steel enclosed firebox. Save 60% on installation. Move intact. Price..... $5000.00 each

3 ea. Kewanee #587, 125#, all gas fittings, etc. 1943 Complete, ready to operate. Location: Palacious, Texas. Price ..... $4250.00 each

2 ea. Kewanee #590, 125# Location: Fort Worth, Tex. 1941 Price $4250.00 each

Also, complete stock 10 HP to 720 HP.

We own them.

S. I. JAFFE CO.
1534 Texas, Box 4111, Memphis, Tenn.

EQUIPMENT FOR SALE

AVAILABLE for sale and immediate shipment #1 T & C 2" line pipe, seamless and lapweld casing, tanks. Call or write Edco Pipe & Supply Company, Box 565, Drumright, Oklahoma.

REVERSE Circulating Drilling Rig consisting principally of Type J Guiberson head; 53GA King swivel; 3" x 28' Guiberson kelly, Waukesha XAHU rotary motor; 5 x 8 Gardner-Denver pump with Mercury motor; 7' x 12' steel tool house, circulating tank; 2—4" x 20' drill collars; hose, valves, miscellaneous connections. All equipment practically new. Price: $8,500. McDaniel Well Service, Seminole, Okla.

CASING: Good used Lapweld, 5½" 13 lb.—$1.45; 7" O.D. 17 lb., No. 1 grade—$1.50; 2,000 ft. 8⅝" 24 lb.—$1.90; Good 10¾" 32 lb.—$2.75; Special 10,000 ft. 2" lapweld tubing, 11½-V threads—35c. Cable drilling and fishing tools for sale or rent. We buy surplus cable drilling tools. Phone 7-5121, H. P. McGinnis, Tri-State Tool and Supply Co., Parkersburg, West Virginia.

BOILERS FOR SALE: 18 Code Oil Field Boilers, 50 to 87 H.P., 100 to 200 Lbs. W.P., Operated Under Hartford into 1948, Not Fired Since. Located on Leases Vicinity Pampa, Texas. Offered Subject to Prior Sale. $500.00 to $700 each, as is, where is. Contact Max Harbison, Kewanee Oil Company, Pampa, Texas.

FOR SALE: One 350 KW, 480 volts, 3 phase, 60 cycle; and one 480 KW, ditto, Superior natural gas engine generating units, complete with generating panels. Max E. Landry, Inc., 436 Mayo Building, Tulsa, Oklahoma. Phone 5-5639.

FOR SALE

9—230 H.P. Bessemer Type 10 Engines with compressors, Steel Buildings, Valves, and Fittings complete for installation. Located Salem, Illinois Oilfield.

ENGLE PETROLEUM, INCORPORATED
Box 655, Evansville, Indiana
Telephone 5-5179

EQUIPMENT FOR SALE

D-13000 Caterpillar, Dual fuel, Twin Disc PTO heat exchanger safety shutoff. Electric starter, 570 hr. Council Grove Ice Co. Wesley Steinhoff, Council Grove, Kansas Phone 213.

1—Model 36-L Bucyrus-Erie Spudder mounted on skids, equipped with casing tackle strut, Waukesha GK-140 Gas-gasoline engine with butane attachments, about 3500 feet of ⅞" and ½" lines, and ⅞" tubing line, steel dog house, junk rack, and butane tank. Excellent condition. Price $16,000.00. Also available tailing in or top to bottom tools. 1—Model 24-L Type "EB" Spudder with 48 foot derrick, casing tackle strut, catheads, HP326 engine, cables, steel dog house, Kohler light plant, and complete tools for 6⅝", 8", and 10" hole, derrick house and platform. Price $10,000.00 1—Model 21-W Bucyrus-Erie truck mounted Water Well machine with tools for 6" and 8" hole. Price $3250.00. Randall-Zogg Supply Co., Princeton, Indiana.

FOR SALE: 37, 6" and 2, 8" #1700-F Walworth Lubricated Plug Valves, condition new. Bargain price. Box D-757, The Oil and Gas Journal, Tulsa, Oklahoma.

FOR SALE—AS IS: MD8 Trackson Pipe Layer complete with Standard Boom, cable and sheaves; 3500# counterweights—$4,000 Edward H. Ellis & Sons, Inc., Rt. 40 & Harvard Ave., Merchantville, 10, N. J.

FOR SALE: 1600 ft. 8⅝ inch, 32#, range two, seamless oil well casing. Strictly first class. C. H. Reser, Hamilton, Kansas.

FOR SALE: 300 Amp Westinghouse welding machine powered by 6-BK Waukesha engine. Completely overhauled. Less than 50% of new price. Melton Supply Company Box 1360, Seminole, Oklahoma.

3—160 CUBIC FOOT Air Compressors. Diesel: Gasoline. J. C. Morrison, Midwestern Drillers, Liberal, Kansas. Phone 2441.

FOR SALE: 2 Fairbanks-Morse gas engines No. 208-108, excellent running condition. Mid-Illinois Petroleum Co., 1104 Fayette Ave., Springfield, Ill.

FOR SALE: Approx. 10,000 ft. 4½" OD Heavy Tubing, ⅜" to 9/16" Wall, random lengths 12 to 18 Ft. Also, 5" OD Heavy Tubing, ½" Wall. Both good used condition. M. Kaplan & Son, P. O. Box 1883, Phone 5112, Monroe, La.

TWO USED 5,000 Bbl. Bolted Steel Tanks stacked in my yard. Tanks are 10-10-12-12-12 Ga. Will sell both for $3,500. Hanson Tank Company, Kilgore, Texas.

FOR SALE: Westcott, Foxboro and Emco Gas Meters, Geo. R. Milner. Box 124, Okmulgee, Oklahoma.

FOR SALE: One Double Drum Franks Well Servicing Unit. Mounted on an International Tandem. Complete with all tools and lines. 65' mast. Reasonable. C. E. Knight, Box 4, Holliday, Texas.

CARDWELL double pole telescoping mast, Cardwell spudding attachment, cable tools, sand lines, drilling lines, bailers, tubing tools. Phone 443 Yukon, Okla., or 6-1615, Okla. City.

NEW COUPLINGS

1600 2" 10 R.T. non-upset tubing
50 5½" 10 V thread casing
96 7" 10 V thread casing
2 7" 8 R.T. casing
79 6⅝" 10 V thread casing

Used Couplings

762 2" 10 R.T. non-upset tubing

Rock Island Oil & Refining Co., Inc.
321 West Douglas, Wichita, Kansas
Telephone 5-5674

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10" CASING

3,000' — 10¾" OD, second hand, 40.48#, T&C, lapweld casing

Horwitz Pipe & Steel Co.

415 S. Western Oklahoma City, Okla.

LINE PIPE FOR SALE

100,000' 2⅜" O.D. 3.75# & 4# Good Used Lapweld T&C Range 1 Line Pipe

10,000' 2½" O.D. x .125" Wall 3.1# New Seamless Steel Tubing, Plain Ends, 16' to 26' Lengths

90,000' 4" O.D. x .130" Wall Seamless, 5.4#, Used as sweet gas line, taken up in 30' Lengths. Above ground and available for immediate inspection and delivery, FOB Mobeetie, Texas.

75,000' 6⅝" O.D. 18.97# Excellent Grade Used Lapweld, Machine Cleaned, Torch Beveled Ends 30°, 20' RML.

15,000' 10¾" O.D. 40# Good Used Lapweld, P.E., 20' Lengths.

10,000' 18" O.D. x .312" Wall 59.03# New Electric Weld, 40' Lengths

4,000' 20" O.D. x .312" Wall 65.70# New Electric Weld, 40' Lengths

CASING & TUBING

25,000' 2⅜" O.D. 4# Good Used Lapweld Range 1 Tubing with New 10 Round Threads and Collars.

7,000' 7" O.D. 20# Good Used Lapweld Range 1 T&C Casing 10 V-Thd.

5,000' 8⅝" O.D. 25# Good Reconditioned Casing, 8 V-Thd., T&C, Range 1

5,000' 10¾" O.D. 40.5# Good Used Lapweld T&C Casing, Range 1, T&C, 8 Thread

OTHER SIZES OF LINE PIPE, SEAMLESS TUBING IN SUITABLE SUBSTITUTE SIZES FOR STANDARD PIPE (EXCELLENT FOR GAS, GATHERING AND FLOW LINES), CASING AND TUBING AVAILABLE FOR IMMEDIATE DELIVERY.

FOR FURTHER INFORMATION, WIRE OR PHONE AT ONCE

A. J. STRUBEL

SIDney 1791 ... 4946 Murdoch, St. Louis, Mo.

EQUIPMENT WANTED

WANT to buy: Used BUCYRUS ERIE 28-L spudder drill, used 7¼ x 12 EMSCO Mud Pump. CM. BARRINGTON, Box 831. Coleman, Texas. Phone 4915.

WANTED TO BUY: Bucyrus-Erie 36-L or 28-L. Must be in good condition. Raymond Commons, 501 J Street, Rupert, Idaho. Phone 193-R.

RECORDING GAUGES WANTED
State pressure and if daily or longer. R. L. Pattinson, Aylmer, Ontario, Canada.

HELP WANTED

PETROLEUM Engineer or Geologist with experience in evaluation and subsurface studies in Gulf Coast wanted by sound independent. Age 30-45. In application state salary expected and enclose college transcript. Box D-631, The Oil and Gas Journal, Tulsa, Oklahoma.

CRUDE Oil Treating Engineer, minimum 2 years' experience, college graduate preferred. Headquarters Oklahoma City, territory covers 10 states. Salary commensurate with experience. State education, background, experience, etc. Reply Sohio Petroleum Co., Industrial Relations, Skirvin Tower, Oklahoma City, Oklahoma.

CHEMIST OR CHEMICAL ENGINEER

For interesting Light Products Research & Development Section Rocky Mountain Refinery. Young college graduate preferred. Send photo with data sheet.

Box D-764, The Oil and Gas Journal, Tulsa, Oklahoma

SALES ENGINEERS
OPERATIONS SUPERVISORS
PERFORATOR OPERATORS

Only Experienced Men Need Apply
WRITE ONLY

WELEX JET SERVICES, INC.
3909 Hemphill Street, Fort Worth 9, Tex.

ENGINEERS

Major oil company operating in the Middle East requires graduate engineers in the following classifications:

SENIOR PROCESS ENGINEER
GEOPHYSICS ENGINEER
GEOLOGIST (SEISMOGRAPH)
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ASST. CHEMICAL ENGINEERS
ASST. CHEMIST (ANALYTICAL)
GEOLOGICAL DRAFTSMAN

Also we have positions for experienced and inexperienced civil, mechanical, electrical, construction and highway engineers.

If interested, write giving full outline of personal and employment history.

Box D-728
The Oil and Gas Journal
Tulsa, Oklahoma

HELP WANTED

FOR IMMEDIATE employment. Trainee experienced Observers, Surveyors and computers. For seismic exploration crews. Age limit 42 years. Domestic and foreign work. Submit experience record in first letter. All replies confidential. Box D-730, The Oil and Gas Journal, Tulsa, Okla.

EXECUTIVE Assistant—Petroleum Engineering education with responsible production experience and administrative ability—Age 32 to 40. Replies confidential. Location Shreveport. Box D-760, The Oil and Gas Journal, Tulsa, Oklahoma.

ELECTRICAL ENGINEER: New large oil pipeline company requires electrical engineer to handle design, construction and devise maintenance procedures, all classes equipment to 5-KV switch gear. Some familiarity with sub-stations to 110-KV, 5000-KVA desirable but not required. No communications or electronics involved. Include full professional and personal details and minimum salary, first letter. Job is permanent. Box D-761, The Oil and Gas Journal, Tulsa, Oklahoma.

A LARGE Refinery in the middle West wants Chemists, Chemical Engineers and Mechanical Engineers. State full qualifications in first letter. Write Box D-762, The Oil and Gas Journal, Tulsa, Oklahoma.

SEISMOLOGIST for work with major oil company in Venezuela. Ten years' experience with four years interpretive work, family status, salary commensurate with experience and ability. Give full details in reply to P. O. Box 2819, Dallas, Texas.

PETROLEUM ENGINEER (JUNIOR) with at least one year production or drilling experience to work for major oil company in Venezuela. Single status. Give full details in reply to P. O. Box 2819, Dallas, Texas.

POSITION Available February 1, 1951, Assistant or Associate Professor with Masters degree or higher in Petroleum Engineering to teach reservoir engineering courses in rapidly growing school with excellent laboratory and other facilities. Qualifications will determine salary, but will be comparable to industry. Location Southwest. Box D-765, The Oil and Gas Journal, Tulsa, Oklahoma.

MANAGER-OPERATOR for natural gas system. Excellent opportunity for young engineer with gas experience. State age, experience, salary expected and when available. Write P.O. Box 155, Quitman, Miss.

PRODUCTION MAN WANTED
If you want to make a change, we can pay good salary. Man can also buy leases and royalties. Production is approx. 6000 ft. North Texas. Age 40-50. All applications and information held confidential. Write Box 1824, Oklahoma City, Okla.

WANTED: Chemical Engineers for process development and process design on petroleum refining and chemical processes. Prefer individuals with several years' experience in one or both of above fields. Southwest location. Write F. J. Heller, Research and Development Department, Phillips Petroleum Co., Bartlesville, Oklahoma.

LAND MAN, with experience, for oil company, in Shreveport, Louisiana, area who can handle executive responsibilities. Replies confidential. Box D-740, The Oil and Gas Journal, Tulsa, Oklahoma.

OPERATING MANAGER NEEDED

for small, independent oil company with producing properties West Texas and Oklahoma. Prefer petroleum engineering graduate with minimum of five years field experience.

Box D-766, The Oil and Gas Journal Tulsa, Oklahoma

OFFICE MANAGER—CHIEF ACCOUNTANT

Excellent opportunity for man experienced and qualified in oil accounting with well-established, integrated Oil Company. Send photo with data sheet.

Box D-767, The Oil and Gas Journal Tulsa, Oklahoma

HELP WANTED

FOREIGN and Domestic Oil Employment Directory covering the oil industry, showing where to apply for jobs. Price $5.00. Oil Industry Mailing List, Box 2603, Tulsa, Okla.

SITUATIONS WANTED

ATTENTION: Well established oil well drilling contractor desires to manage and supervise: Individuals', groups', small or medium-sized oil companies' drilling, production and operating problems in Central and Western Texas, and New Mexico. Personal interview by appointment is desired. Makin Drilling Company, Box No. 131, Ph. No. 131, Hobbs, New Mexico.

DRILLING Contractor operating in West Texas and New Mexico desires to contact small or medium-sized independent oil company who needs an operating manager. Personal interview desired. Twenty years experience in all phases of the oil industry. Address replies to Box D-644, The Oil and Gas Journal, Tulsa, Oklahoma.

IF you are a service company serving the oil industry and need an experienced salesman, contact W. A. Anderson, 5015 Cowper, Dallas 5, Texas. Excellent references furnished upon request. Have spent a number of years selling oil field supplies, handling advertising accounts, and establishing material outlets. Prefer commission contract with established oil firm.

SALES ENGINEER successfully selling oil field machinery in West Texas desires change. Married, 28, and graduate of U. S. Naval Academy. Prefer sales or job with drilling contractor. Box D-758, The Oil and Gas Journal, Tulsa, Oklahoma.

MAJOR COMPANY GEOLOGIST, graduate training, extensive experience, wants position Mid-Continent or Rockies with major company or independent. Box D-744, The Oil and Gas Journal, Tulsa, Oklahoma.

MANAGER of small producing company liquidated because of death of principal stockholders seeks employment with owners or prospective owners of oil production in Oklahoma, Texas, New Mexico. Nineteen years experience in leasing, drilling, producing. Have good connections for farmouts and drilling blocks. Can furnish office and automobile. Boxholder 11054, Fort Worth, Texas.

QUALIFIED Purchasing Agent, warehouse operations, also accounting and public relations experience. Desire change, married, age 42. Box D-759, The Oil and Gas Journal, Tulsa, Oklahoma.

REGISTERED MECHANICAL ENGINEER desires to invest in and assume engineering position with pressure vessel and/or tank fabricator for Tulsa area. Box D-739, The Oil and Gas Journal, Tulsa, Oklahoma.

GEOLOGIST, age 36, married, over five years experience in subsurface work with major companies in Mid-Continent and Gulf Coast, desires change. Box D-746, The Oil and Gas Journal, Tulsa, Oklahoma.

PUMPER understands production treating oil and upkeep of equipment, available. Box D, Carney, Okla.

TOOL PUSHER: Available immediately, 12 years experience large and medium sized rotarys. Worked in ten states, can furnish good references. Box D-763, The Oil and Gas Journal, Tulsa, Oklahoma.

REAL ESTATE

RETIRE IN CALIFORNIA

Prominent oil and gas producer, recently widowed, desires to dispose quickly of his executive type mansion on landscaped 3 acres in choice section of Los Angeles area for less than 20% of replacement value. One of the finest homes in Southern California.

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DEEDED ROYALTIES
San Juan Basin & Permian Basin. Write Harry S. Wright, Wright Bldg., Farmington New Mexico.

MONTANA ROYALTIES
Millions of acres now leased by world's major companies, with huge drilling play in prospect. For booklet describing Montana geology and oil development, write Landowners Royalty Company, Box 1225 Great Falls, Montana.

WE will buy producing or non-producing oil royalties. Standard Security Company, 115 Broadway, New York 6.

REAL ESTATE

FOR RENT or Lease in Brownfield, Texas: 150′ x 140′ lot on Main Street, 1½ blocks from Court House. Very desirable location; owner will build to suit tenant. This Terry County area is now being developed by major companies. H. H. Hughes, Box 707, Brownfield, Texas.

BUSINESS OPPORTUNITIES

FOR SALE: Drilling and well servicing business, 4 rigs on locations in Rocky Mountain Area. Yearly gross $400,000.00. Ill health reason for selling. Box D-751, The Oil and Gas Journal, Tulsa, Oklahoma.

PATENT ATTORNEYS

PATENT Practice before U. S. Patent Office. Validity and Infringement Investigations and Opinions. Booklet and form "Evidence of Conception" forwarded upon request. Lancaster, Allwine & Rommell, Registered Patent Attorneys, Suite 418, 815-15th Street, N.W., Washington 5, D. C.

LEGAL BLANKS

BURKHART LEGAL BLANKS since 1908. Oil-Gas (all states), Business, Real Estate, Legal Forms, Leases, Revised With Government Regulations, Commercial Printing. Catalog and Samples on request. Burkhart Printing & Stationery Company, 115 South Cincinnati, Tulsa 3, Oklahoma.

FOR SALE

FOR SALE, rare OIL FIELD books, Oil Fields of Russia with large map of field, by A. Beeby Thompson, also by same author Petroleum Mining and Oil Field Development. A. E. Osborn, Box No. 1, Fort Smith, Arkansas.

TITANIA GEMSTONES

Can supply the new sensationally beautiful synthetic titania gemstone "rainbow diamond," facet cut, showing greater brilliance than the diamond and at a small fraction the cost. Harder than amethyst. Christmas is coming.

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H. McGAUGHEY
P.O. Box 11063, Houston, Texas

LEASE AND DRILLING BLOCKS

U. S. LANDS in Colorado can be filed for Government oil lease in developing area. Good opportunity. Small Expense. Write S. W. Pressey, Pueblo, Colorado.

HAVE 45 STAR rig complete with tools ready to run, also 7″ and 8″ and 10″ casing; will put use of rig and tools in on drilling deal for working interest in well. Must be good location. Or will sell. Rig located near Rose Hill, Virginia, near Cumberland Gap, Tenn. B. N. Cardwell, 204 North 19th St., Middlesboro, Kentucky.

FOR SALE: One hundred fifty acre oil lease, eight old wells all pumping, twenty good locations to drill, two and one-half miles north Scottsville, Kentucky. Buel Wilson, Scottsville, Kentucky.

OIL AND GAS LEASES, Shelby County, Texas. Holdings in and around active major company blocks. Write for full details. Box D-722, The Oil and Gas Journal, Tulsa, Oklahoma.

LEASES ROYALTIES

The Next Big Oil Play
Atoka County, Oklahoma

Thick Oil Sands — Shallow or Deep
Inquiries Invited

A. G. BLAUNER, Atoka, Oklahoma

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B. D. BUCKLEY
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Leases and Royalties

ALBERTA LEASEHOLDS
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Calgary, Alberta, Canada

LEGAL

U. S. DEPARTMENT OF THE INTERIOR, Bureau of Land Management, Washington 25, D. C. Notice is hereby given that 520 acres in T. 2 N., R. 12 E., E.C.M., Oklahoma, within the known geologic structure of the Hugoton field, will be offered for oil and gas leasing in three parcels, through competitive bidding, at 1 p. m. Eastern Standard Time, November 29, 1950, when bids will be opened. The details of the lease offering and how and where to file bids may be obtained by addressing an inquiry to the Regional Administrator, Region V, Albuquerque, New Mexico, or to this office. Marion Clawson, Director.

LEGAL

U. S. DEPARTMENT OF THE INTERIOR, Bureau of Land Management, Washington 25, D.C. Notice is hereby given that the NW¼NW¼ sec. 8, T. 9 N., R. 8 W., St. Stephens Meridian, Mississippi, 40 acres, within the known geologic structure of the Eucutta field (undefined), will be offered for oil and gas leasing, through competitive bidding, at 1 p.m. E.S.T., December 6, 1950, when bids will be opened. The details of the lease offering and how and where to file bids may be obtained by addressing an inquiry to this office. Marion Clawson, Director.

LEGAL

U. S. DEPARTMENT OF THE INTERIOR, Bureau of Land Management, Washington 25, D. C. Notice is hereby given that the W½NE¼ sec. 8, T. 31 S., R. 25 E., M.D.M., California, 80 acres, within the known geologic structure of the Coles Levee field, will be offered in one parcel for oil and gas leasing, through competitive bidding, at 1 p.m., Eastern Standard Time, November 29, 1950, when bids will be opened. Details of the lease offering and how and where to file bids, may be obtained by addressing an inquiry to the Manager of the Land Office, Sacramento, California, or to this office. Marion Clawson, Director.

Exploration Meet Planned

FORT WORTH.—Exploration problems of south-central oil provinces will be discussed at a regional exploration meeting which will be held at the Texas Hotel here November 30-December 1.

Papers will be presented covering geology and geophysics of the various areas, and general-interest topics also will be discussed.

The meeting is under joint sponsorship of the Fort Worth Geophysical Society, Fort Worth Geological Society, Dallas Geophysical Society, Ark - La - Tex Geophyhical Society, Permian Basin Geophysical Society, and Geophysical Society of Tulsa.

EQUIPMENT MEN

(Continued from page 411)

Co., in June 1948, Bell was employed by Consumers Power Co., in Jackson, Mich., and later in the mechanical engineering department of the former Commonwealth & Southern Co., in Jackson, now Commonwealth Associates.

Skilling Named by Edward As District Manager

Thomas E. Skilling has been appointed Pittsburgh district sales manager for Edward Valves, Inc. As Edward representative in the area, he succeeds Herr-Harris Co. Skilling, who has been associated with the Herr-Harris Co. for several months, will continue his office in Pittsburgh.

A graduate mechanical engineer of Lehigh University, Skilling has been with Edward in home office engineering and sales work since 1947.

The Herr-Harris Co. and its principal, Benjamin M. Herr, have been affiliated with the Edward organization for more than 30 years. Skilling will continue to work closely with Herr-Harris Co.

Industrial Engine Men Guests of Home Office

Fifty-one dealers and key men in their organizations attended a 4-day conference held by the Industrial Engine Division, Chrysler Corp., in Detroit late in October. The program largely was given over to what might be termed a "clinic," in which every possible phase of selling and servicing industrial engines of Chrysler manufacture was discussed. There were two daily sessions Monday through Thursday, with J. C. Hammelef, manager of the Industrial Engine Division, presiding, assisted by R. H. Westrick, service manager; C. H. Williams, project engineer; and all members of the field force. Robert T. Keller, president of the division, headed the group of hosts.

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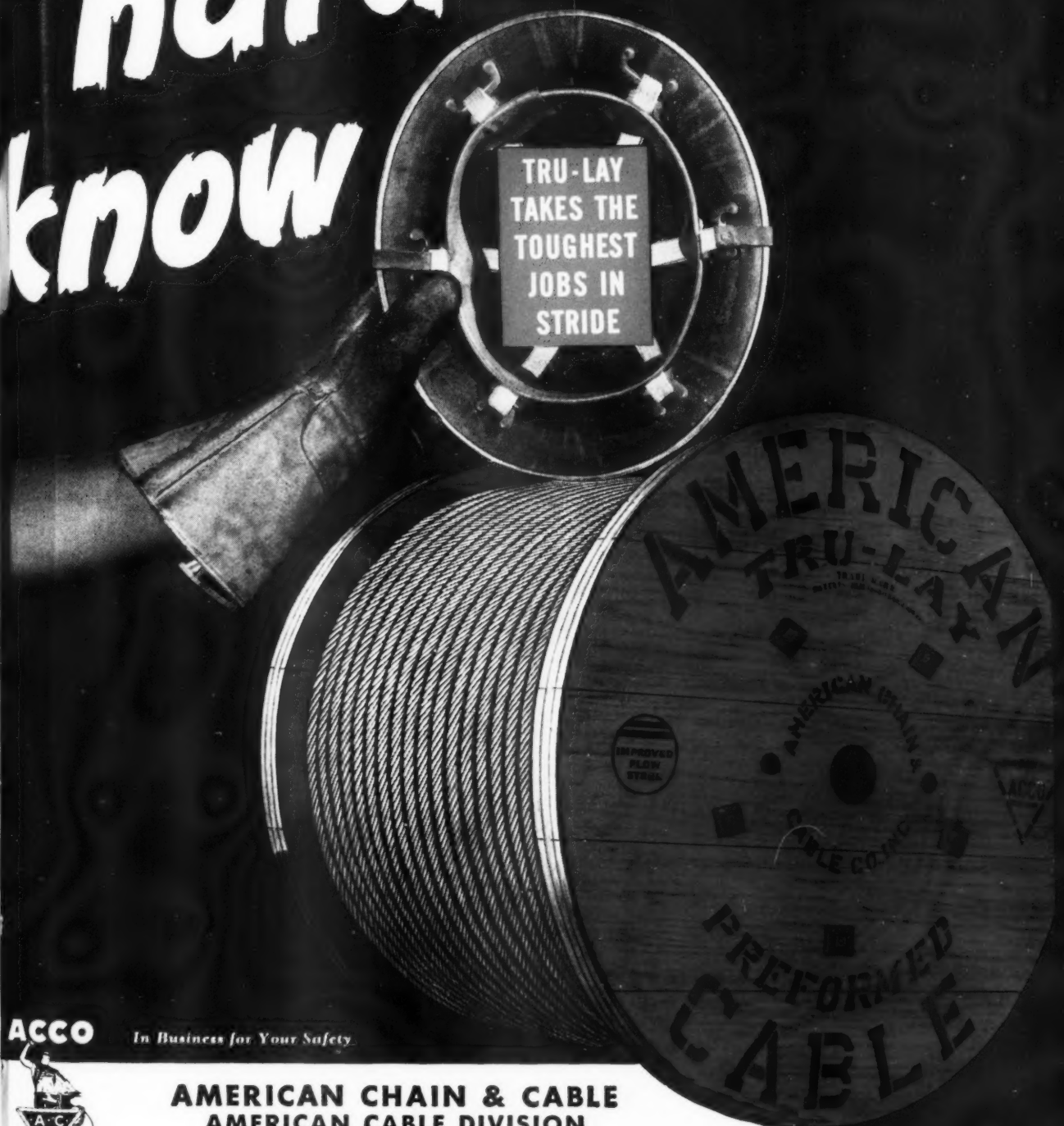

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